Materials & Methods

THE METALWORKING INDUSTRIES' ENGINEERING MAGAZINE

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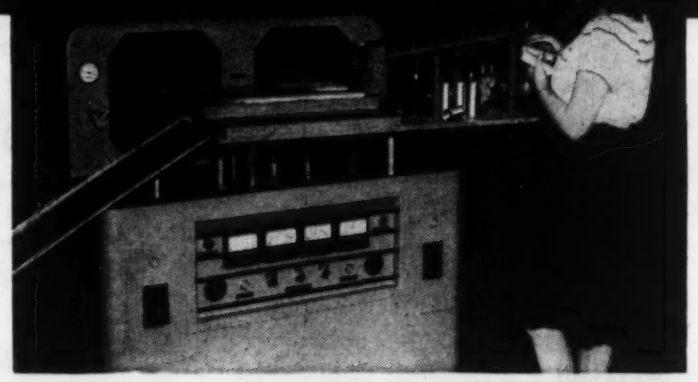

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The MATERIALS OUTLOOK...

Metals Situation in General

It looks as though prices of the common base metals will close the year at substantially the same levels as now prevail, despite increasing supplies. One important reason for expected stability is the extremely cautious buying policy these several months. Thus, there is no surplus metal to be dumped on the market. Too, for the first time our Government is taking serious steps to accumulate stockpiles, thus to absorb any surplus that might depress prices. Shortages of lead, rife a few months back, are no more, thanks to large imports, better supply of miners here, and increased home production. Previous worries over copper supply came to naught. The over-all supply of zinc is satisfactory, save for certain grades here and there. Though President Truman in August vetoed the first bill to give bonuses to high cost metal mines, it is predicted another and modified bill will pass in January, the bonuses to be paid to mines whose metal will be Government stockpiled.

Contrasts in Plywoods

There is considerable contrast between supply conditions of softwood plywoods and hardwood plywoods. Demand for Douglas fir plywood and other soft-wood products still far outstrip supply. Hence the Civilian Products Administration continues to apply the rationing system. In hardwood plywoods, however, the supply is ample. Soft-woods will continue scarce throughout the foreseeable future.

Lead Substitutes Listed

With lead at all-time high prices lead producers are watching closely for substitutes for lead in the following applications: Aluminum in foil and collapsible tubes; plastics for cable sheathing; substitutes for tetraethyl lead in high octane gasoline; titanium dioxide, zinc oxide and zinc chromate in paint; steel, iron, copper, brass and plastics in plumbing; rubber, ceramics, glass, stainless steel, Monel and plastics in chemical equipment; DDT and other compounds in insecticides; roller bearings instead of babbitted bearings; concrete in X-ray and nuclear protection. Somewhat offsetting any losses will be increased uses in atomic fission.

Cheap Calcium Possible

During the war the New England Lime Co., Canaan, Conn., converted part of its magnesium plant, ferro-silicon process, to production of metallic calcium, some of which was used during the war as a scavenger in production of airplane steels where very high qualities were needed. Current prices on calcium are variously quoted at $1.60 per lb. in ton lots, cast in slabs and small pieces; $1.85 in form of so-called carrots, and $3.00 for distilled metal. It is said authoritatively that it could be produced and marketed at well under $1 per lb. if enough market could be found for around 3,500 lb. daily.

Calcium Extrusion Feasible

And—speaking of the need for a market for 3,500 lb. of calcium daily, we know of a Brooklyn plant where calcium may be extruded into rod, bar, shapes, wire or strip form for adaptability to specific process industries. Also, the loose distilled crown produced by New England Lime Co. can be converted to a dense homogeneous metallic structure. Calcium sheet has been rolled—it does so beautifully—and from an extruded slab. The availability of the wrought forms should broaden the possibility of application in the process industries. At $1 per lb. for the metallic calcium some interesting development should be forthcoming soon.

Chromium Super Alloys

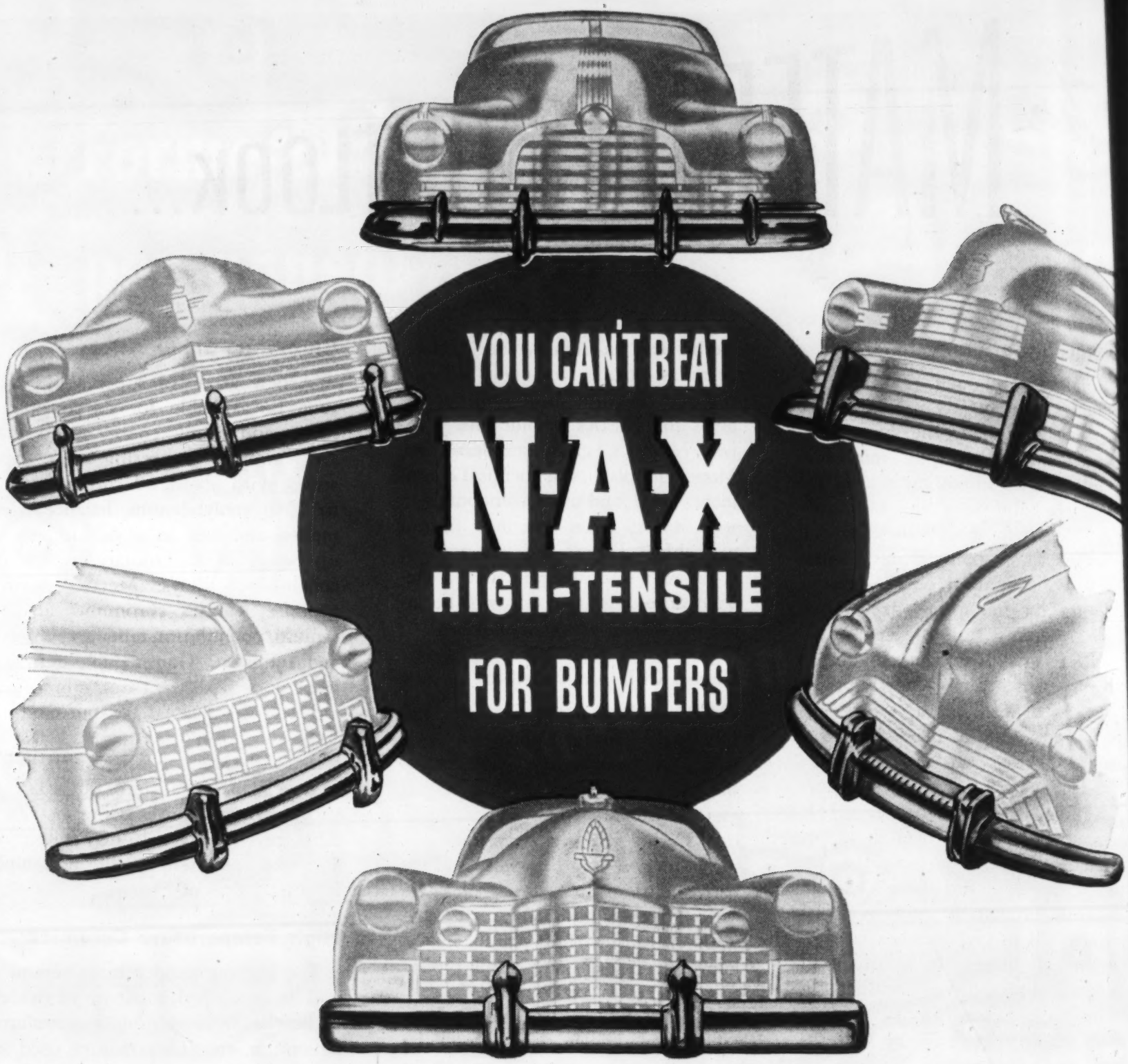
A new group of super alloys will soon be available for the turbo-jet, rocket and atomic energy plants that are "simply staggering." A new series, with about 60 chromium, 15 to 25% molybdenum, balance iron, melted and cast in a vacuum, show up better in preliminary tests than cobalt-based alloys. Metals offering promise, besides chromium, are titanium, columbium, tantalum, "moly" and tungsten. Considerable remains to be done with the chromium alloys. Occasionally heats have outstanding stress-rupture properties at 1600 F, but results aren't consistent in heats of 2 or 3 lb. in vacuum. But a larger vacuum installation is being installed. Also, promising leads may result in alloys of consistent quality and high level of properties.

High Temperature Ceramics

For highest temperatures ceramics will be developed, made up of oxides of beryllium, aluminum, magnesium, zirconium, etc. They may be used as coatings for metals, as structural combinations with metals, or as individual parts. Of course, they have poor mechanical properties which must be improved or compensated for by design. They may be expensive, but worth the price.

Sinter Substituting for Scrap

Look for an increasing quantity of sintered iron ore in place of diminishing quantity of steel scrap. Low grade Mesabi ores and taconites can be formed into solid chunks of iron, the light sinter for blast furnaces and heavy sinter for open hearths. Such sintering plants can be quickly and cheaply constructed. A large steel company has already gained much experience with the process on Adirondack magnetites. The sintering makes captive the fines that would ordinarily escape up furnace flues.



Bumpers and similar parts that require good cold-forming quality in steel are stronger and more economical to produce when made of N-A-X HIGH-TENSILE.

N-A-X HIGH-TENSILE's resistance to deformation (denting) is 60% greater than the denting-resistant quality in carbon steel. Its inherently fine grain and higher hardness provide a better surface texture for plating.

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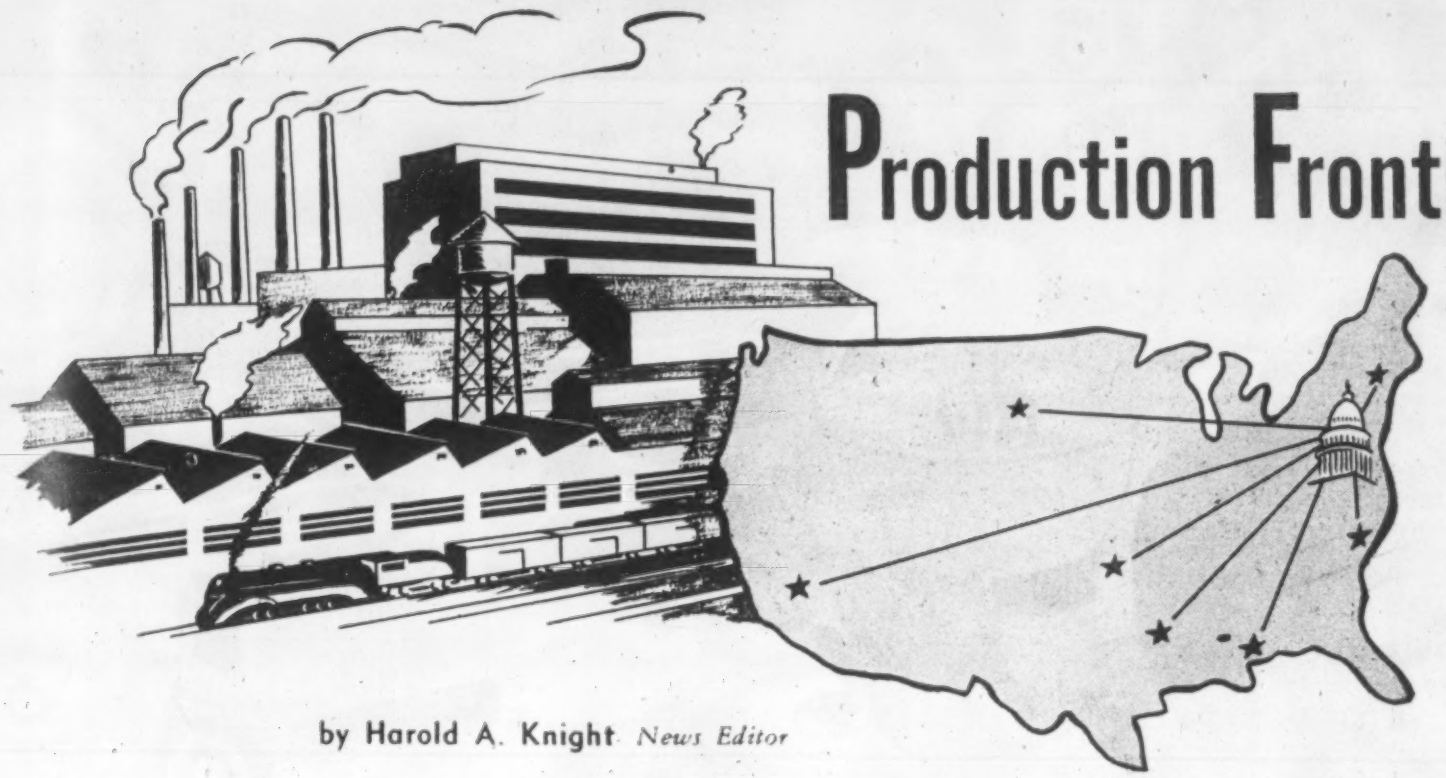

Production Frontiers

by Harold A. Knight *News Editor*

Lights are Green for High Output in October

This month of October should bring great satisfaction to economists, industrialists and plain citizens who believe that large production is the key to the solution of our economic ills. In the great barometric steel industry, October is almost invariably one of the great production months of the year. That is a month that is favorable to large output. The weather is ideal, free from strength-sapping heat of summer and crippling snow and ice of winter. Workers are refreshed from summer vacations and captains of industry are in the throes of fresh plans for improvement.

The casual observer senses this quickening of the pace of business and living generally. The newspapers carry double their advertising volume. People with foresight are planning Christmas purchases, which will give marked impetus to business volume. The convention season is in full swing, promoting valuable exchange of ideas. (For an exchange of one idea, see page 71.)

Already this year the retail volume of sales is 20% ahead of last year, due to the fact that the durable goods supply is 40% better. In harmony, is the fact that the income level is higher than ever before in peacetime, at the rate of $178,000,000,000 annually. It is more evenly distributed than usual, too.

For the first eight months this year production of steel ingots has been 56,000,000 tons, or at an annual rate of 85,000,000 tons, the highest for a peace year in history and 60% above the 1939 output.

Local Disputes Handled Locally

It looks, too, as though labor and management are getting somewhat closer together and realizing that harmony is the best formula for both sides. Perhaps more communities will follow Philadelphia's example, for instance, which has formed an organization for voluntary settlement of labor-management disputes without recourse to government intervention. Known as the Philadelphia Mediation Council, it consists of an advisory and policy-making board of six management and six labor representatives and a panel of mediators chosen by the two groups. The idea is to "handle local disputes by local people."

Under the heading of national distribution, ones attention is called again to that pace-setter among the railroads, Robert R. Young, chairman, Chesapeake and Ohio, who in his latest blast accuses the carriers with hauls from California to Chicago of having standardized the running time for freight trains to exactly 118½ hr., though among the eight railroads routes vary in length by as much as 450 miles. Another case of stifling competition, it would seem—that is if it is true.

Contribution on Shotpeening

We know of at least two awards for contributions to technology made within recent months because of the honored one's development of shotpeening. It is doubtless, then, an important subject on which anyone interested in materials should keep well posted.

Fred K. Landecker, manager, Metal Improvement Co., made, we think, some contributions to the data on the subject when he read a paper before the SAE National West Coast transportation and maintenance meeting at Los Angeles in late August.

He says that shotpeening and shot blasting are often used interchangeably, but the former is the correct nomenclature where the aim is to benefit by stressing a part subject to fatigue, shock or impact. "Blasting" is more properly applied to the cleaning process in which grit or broken up shot are used to obtain abrasive action. On the contrary, broken shot in peening must be avoided meticulously as the corners will produce

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scratches to act as stress concentrations. The shot itself fatigues and breaks up and must be separated constantly while peening.

It is nearly impossible to overpeen, but underpeening is a constant danger, as the part is liable to have spots not fully peened, hence subject to failure. Peening can save many man and machine hours by eliminating costly grinding and polishing.

Peening has to be virtually the last operation, since machining will destroy the thin compressive surface. However, a sufficiently light lapping or honing is often beneficial. An extreme case illustrating the niceties of lapping was the case of compressor discharge valves, 0.044-in. thick. Life was increased when 0.002 in. was lapped from the surface, but with 0.003 in. removed the benefits from peening had nearly completely vanished.

Shotpeening has been found just as effective on nonferrous metals. On magnesium and soft aluminum one must use shot made of walnut shells, apricot pits, plastic or glass. Peening, as any work hardening process, also produces a slightly harder surface. In case of high manganese steel and Inconel, the increase in skin hardness is quite substantial.

The theory of it all is interesting. Usually residual stresses are regarded as harmful. But a residual compressive stress on the surface is usually beneficial. Such stresses are accomplished chemically by nitriding and carburizing; mechanically, by shotpeening and surface rolling.

Buyers of automotive equipment should insist that the process be used more frequently and universally.

Exporting Mass Production

It has been said repeatedly that one way to help Europe back on her feet is to export our mass-producing techniques so that the stricken countries can help themselves. We sat near a man who is doing just that at a little dinner in his Newark, N. J. plant for the press and certain Italian-American dignitaries. Another of his plants is in Naples and is mass producing by American methods and materials. Thus, hot-rolled sheets and strips, shipped from here, are cold-rolled on Italian mills.

Mario Caruso, now grey haired, soft-spoken and with an intelligent, smooth face, came to the United States from Messina, Sicily at the age of 17. Last July 31 he started his thirty-second crossing of the Atlantic, Italy-bound. His first job was sweeping out offices in the Lionel Electrical Toy Mfg. Co. And, like the fiction books, became general manager, then Italian representative.

During the early years of the depression in the United States he established his plant in Italy making hardware according to American standards and production methods. The products were sold throughout Italy and the rest of Europe. Though they sell for more than the native artisan products, they are cheaper than imported American products.

After the antipasto, lobster salad, turkey and red wine, Mr. Caruso answered questions on wages and efficiencies of Italian labor at his Naples plant. Over 2,200,000 employable persons in Italy are without work, he said. Hence, a job is a coveted possession even though wages are only 500 lira (80 cents) a day.

Because a job is precious it is carefully nurtured. A machine operator leaves the room, the machine untended. The adjacent workman immediately takes over the additional work without instructions from the foreman. Consequently, Italian labor is more efficient than American—just now at least—according to Mr. Caruso.

Mr. Caruso's present main venture is the manufacture of an electric cigarette vending machine, made of interesting materials, several with zinc chromate finish, and with precise techniques in many parts. His publicity agent claims it the most popular vendor on the market, though only a year old.

The manufacture of this machine is about to be carried on also at the Naples hardware plant. It can be sold from Naples to South America for $225 against $400 for one shipped there from the United States; the differential representing tariffs. The Naples plant working force, now 160 persons, will be expanded to 2,400.

Perhaps the world needs more internationalists such as Mr. Caruso.

Another Watch Spring Alloy

Apparently considerable rivalry has developed among watch manufacturers to develop better alloys for watch springs. Thus, "Elgiloy," of the Elgin Watch Co., was described in a feature article of MATERIALS & METHODS, April, 1947, p. 94, that alloy having been described as strong, relatively hard, nonmagnetic, highly resistant to corrosion, non-setting and otherwise superior to high quality carbon steel springs.

Along comes the Hamilton Watch Co., with a new hairspring made of a new alloy, "Elinvar Extra," which is based on an older alloy developed by a French scientist 30 years ago. It, too, has resistance to rust and nonmagnetic qualities. Metallurgically it is: nickel, 41.00 to 43.00; titanium, 2.2 to 2.6; chromium, 5.1 to 5.7; carbon, 0.06 (max.); manganese, 0.3 to 0.6; silicon, 0.3 to 0.6; aluminum, 0.4 to 0.8; phosphorus, 0.4 (max.); sulfur, 0.04% (max.); balance, iron.

Inco, publication of the International Nickel Co., tells the story. An English watchmaker, Dr. Robert Hooke, conceived the idea of a balance spring in a watch and used a hog bristle (hence the "hair" spring) in 1685. The bristle was later replaced with a steel spring. But these rusted, became magnetized, and modulus of electricity varied with changing temperatures.

In recent years metallurgists of International Nickel and Massachusetts "Tech" have collaborated with Hamilton engineers to improve the alloys and springs. The alloy is made in a tiny induction furnace in an air-conditioned plant at Lancaster, Pa., with capacity for 10-lb. ingots. Special equipment for rolling and drawing into wire has been built.

Processing control is superbly rigid, with but little possibility of error. Each ingot costs $5. After being forged and rolled into rod form it is machined so that all but 2 lb. of the original 5-lb. ingot is lost. This 2 lb. is rolled and drawn into wire so fine that it provides a ribbon of wire 20 miles long, making hairsprings valued at $625,000, sufficient for 250,000 watches using the smallest type hairspring. It would take five to equal the diameter of one human hair. They are mirror-finished to an accuracy of 1/200,000 in.

Slight variations in the composition of the alloy are made, depending on whether use is in pocket watches, men's wrist watches, or tiny women's wrist watches. This near-perfect alloy, in place in the balance assembly, makes possible an oscillation of exactly five times per sec.

Dow: A Half Century Old

A certain graduate of Case School of Applied Science arrived at Midland, Mich. around 1890 to start his life's career making bromine out of the local brine wells. His name was Herbert Henry Dow. At that time Midland was the largest single producer of bromine in the country.

A fascinating saga of a great chemical and metal industry and the men who developed it in typical American fashion is contained in a new booklet, "Fifty Years of the Dow Chemical Co.—Its Progress and Its People".

When young Dow invaded Midland the bromine process was an antiquated one used since 1825 in other localities. Now, Dow found that an electric current passed through the Michigan brines turned it red, indicating free bromine in the solution. He further discovered that air bubbled through would "blow out" the bromine which could then be absorbed in various alkalies to result in usable bromine compounds.

Renting an old barn adjacent to a flouring mill, he rigged up a rope drive from the steam engine to operate his 15-v. generator, paying $12 per day for power. The product was a mixture of bromides and bromates with various impurities. Customers were uninterested.

A company was organized, fresh capital acquired and the plant moved and new equipment obtained but still the product was too impure. By mistake one of the lye kettles was run too far, the contents being a mass of fused salts. The purity was found much improved. The bromates were broken down and the organic matter oxidized, leaving a fairly pure potassium bromide.

Next the company attempted electrolytic production of chlorine. The current had been on for an hour when an explosion wrote "finis" to the plant, sparing personnel. By 1897 chlorine production for the end product, chloride of lime, was a going proposition. Later came carbon tetrachloride, and sulfur chloride, forerunners of a chain of chemicals.

One day a German, Herr Jacobsen, pompous and blustery, visited Mr. Dow and ordered him to cease shipping bromides out of the United States. He was stunned by Dow's refusal to desist. The German threatened him with sales in the United States of German bromine. Dow was more determined. The bromide war lasted three years, the price dropping to 10 cents per lb. By 1909 the Germans had had enough.

His son, Willard H. Dow, took over at his father's death in 1930. In 1932 he accomplished extraction of bromine from sea water. He developed three primary plastics—Saran, Ethocel and Styron. His Styrene helped win the war. In 1936 Dow opened a magnesium foundry and fabrication plant in Bay City, Mich. The first ingot of magnesium to be taken from the sea was poured Jan. 21, 1941, an historic date in the world of science.

The company entered the 1940's with a product list of over 500 items and assets of $48,000,000. A depression had been fought and conquered. Next came World War II. Despite the popular public conception of bloated war profits for munitions makers, Dow actually lost money and handicapped his peace-time recovery by the manufacturing secrets he had revealed to competitors for the nations' good. Saran in screens protected our G.I.'s from insects in the tropics; Styron, in minute fibres, made radar housings for aircraft; Ethocel became part of the proximity shell. Strip-coat protected surfaces.

We like the concluding paragraphs of "Fifty Years" the best of all. We quote: "Herbert Dow, the father, with the help of great men, built a great company from a single idea. Willard Dow, the son, with the help of great men, has not only directed that company through two periods of crisis, but has made it seven times greater in the bargain.

"Through it all have been a few fundamental, significant policies, the foremost of which has been a close adherence to a few basic raw materials provided by nature—brine, sulfur, petroleum. But perhaps in the final analysis the Dow Chemical Company's success lies more in philosophy than in policy. It is Dr. Willard Dow's unshakable conviction that true progress springs more from the spiritual satisfaction of accomplishment than from the hope of monetary reward alone. This is not a mere abstract idea but a conclusion reached through his knowledge of the men who have worked with him and with his father in the company's 50-year course of phenomenal achievement. A corporation, being in itself but a sort of inanimate container, can be no better than the minds and the hearts of the human beings within it.

"Such inspiring human history and heartening human philosophy compose the bright but unreadable prophecy of Dow's second 50 years."

Control of Atomic Energy Materials

If the United Nations should agree on an inspection system for controlling the production of atomic energy materials, it will be fairly easy, with airplanes, to uncover clandestine manufacture, according to the "First Report of the Atomic Energy Commission to the Security Council."

First, mining operations are perforce substantial. Large or characteristic installations are required in the case of isotope separation plants, primary reactors and chemical extraction plants. Large amounts of power are required for isotope separation plants. Large quantities of fresh water are needed, principally as a cooling medium, in the case of certain reactors. Plants will be on rivers or lakes. In the case of reactors and associated chemical extraction plants, radioactive wastes are produced and easily spotted by proper instruments. Extensive shielding against radiation is required in the case of reactors and associated chemical extraction plants.

The policeman will recognize geological formations in which uranium and thorium might be present; he'll recognize mining operations large enough to be potential sources of uranium or thorium. He'll grasp such tell-tale equipment as mass spectrometers, diffusion barriers, gas centrifuges, electromagnetic isotope separation units, very pure graphite in large amounts, heavy water and beryllium in large amounts.

Aerial surveys, combined with ground surveys and direct inspection, are essential in some cases to detect clandestine operations.

New installations, or extensive modifications in existing installations, are readily detectable by comparisons of aerial photos at successive intervals. Camouflage is not effective. Ground surveys may be needed in heavily wooded areas and caves. Of course, plants for chemical and metallurgical treatment of uranium and thorium concentrates may not be distinguished from the peaceful plant. Their products have to be fed into isotope separation plants or reactors having distinguishing characteristics.

AN EDITORIAL

The Metal Show

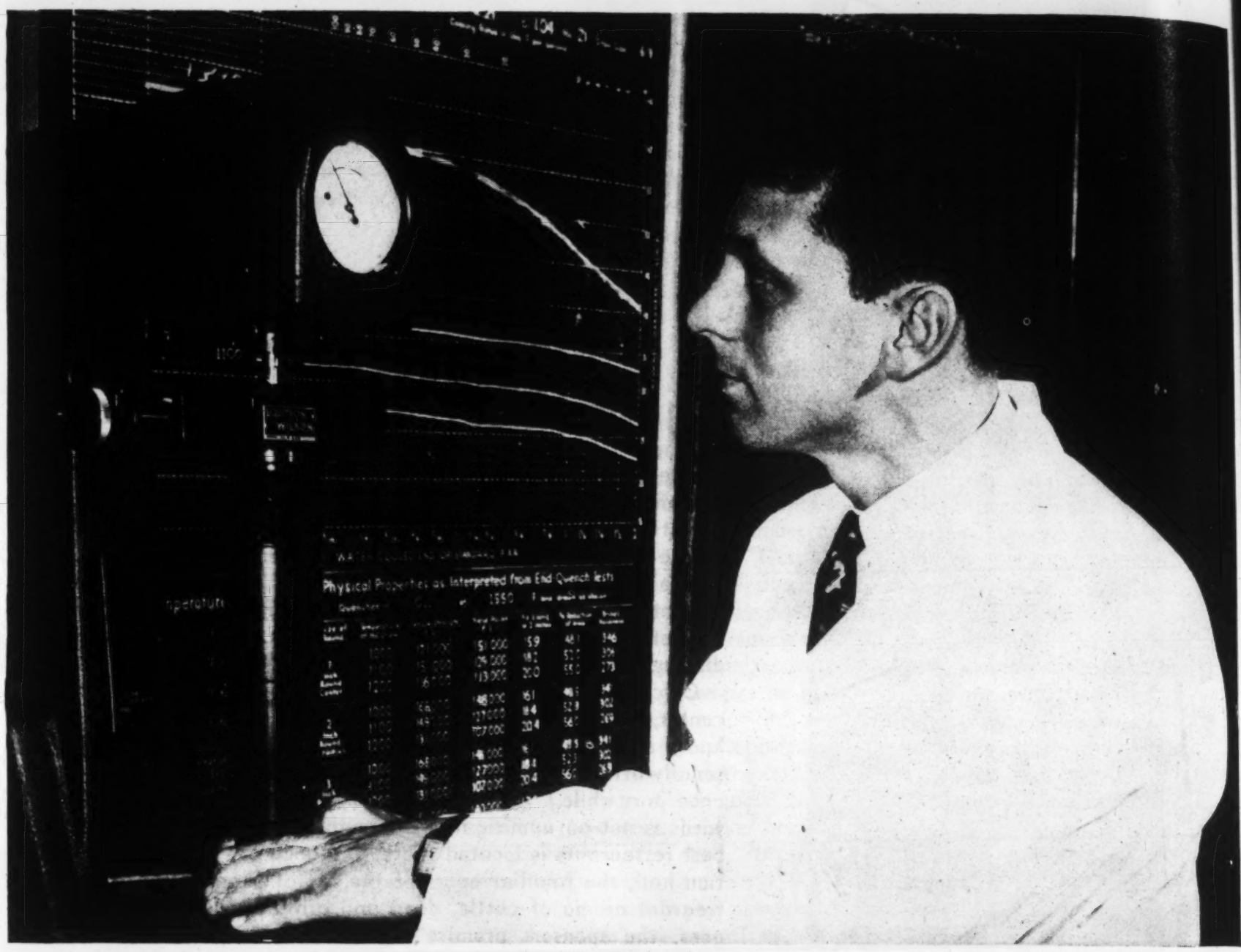
The 1947 National Metal Congress and Exposition, to be held at Chicago October 18th-24th inclusive, will doubtless be as big and bright and busy as ever. An attendance of over 20,000 is expected by the American Society for Metals to attend the technical sessions of the four participating societies and to crowd the Exposition at the International Amphitheatre, at which more than 300 producers of metals, alloys, metal products, and processing equipment will display their wares.

Chicago is a good choice because of its position as an industrial center, and its abundance of good hotels. (We wish New York City had a sufficiently large exposition hall available, so we could personally attend a Metal Show, like the World Series, via the subway once in a while.) Holding the show right next to Chicago's stockyards is not an unmitigated evil, either, since one of the country's best restaurants is located there, and once one is inside the exposition hall, the familiar odors of the Metal Show obliterate the less fragrant aroma of cattle, dead and alive. And so far as distance goes, the sponsors promise regular and frequent chartered bus transportation to and from the Loop hotels and the Amphitheatre to make your shuttling as efficient as possible.

The Metal Show is something no one interested in materials and their processing can afford to miss. But we still believe that a Metal Show every year is an unnecessary burden on the "regular" exhibitors, that a Metal Show held *every-other-year* would be a better exposition than an annual affair can be, and that the biennial arrangement would be more popular than the annual, both with exhibitors as a group and with the engineering public who attend the show. But so long as it *is* being held, the Show is definitely worthy of attendance, and those who go will glean much of value about the products and processes on display as well as from the obviously valuable technical sessions and educational lectures presented as part of the several conventions being simultaneously held.

Our Preview and program for the Congress and Exposition begins on page 109 and includes a number of features to increase its convenience to you, not present in our Previews of other years. And while you're at the Show, stop in at Booth 1337 either just to say "Hello" or perhaps to tell us what you like or don't like about *Materials & Methods* as constituted today.

FRED P. PETERS



Hardenability Buying of Alloys Made Easy by Ryerson Tests

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EDITORIAL COMMENT

Ships and Needles

Several months ago the comprehensive final report on failures in welded merchant ships was submitted to the Secretary of the Navy. It is an important document, for it carefully analyses a highly controversial subject and arrives at some clear-cut and well-substantiated conclusions.

For one thing, the report should fully vindicate the all-welded ship as such. The investigation showed that with proper design, high quality workmanship and a steel which has low notch sensitivity at operating temperatures, a satisfactory all-welded ship structure may be obtained.

Perhaps the Board of Investigation's most important single conclusion was that the fractures in welded ships were brittle failures caused by notches and by steel which was notch-sensitive at operating temperatures. They further found that the notches in the steel where fractures originated were a result of design detail and to a relatively minor degree, poor workmanship.

A very important fact that can be deduced from these conclusions is that designers and production men must have a knowledge of the materials with which they are working. In this case of welded ships it might easily be concluded that the unsatisfactory performance was strictly due to a material failure caused by poor selection or defective steel. However, neither poor selection nor defective steel were critical factors, but rather the fact that the steel's notch sensitivity characteristics were not thoroughly understood and were not taken into account in the design details. Also, to a lesser extent, the notch sensitivity of the steel was not sufficiently considered in fabricating the ships.

Thus, the report serves to emphasize the interdependence of materials, design, and production methods. Though here it concerns only merchant ships, the lesson learned can be applied to the manufacture of any product, whether it be a ship or a knitting needle. —H.R.C.

Beating the Steel Shortage

Twenty-five steel consumers have formed a syndicate and invested $11,000,000 in two Pennsylvania steel plants producing open-hearth ingots, sheet bars and the finished product, steel sheets. Though this is not a new idea in the business world, it is apparently an initial move in the steel industry. Certain publishers have banded together in the past to buy mills for producing newsprint.

Again single corporations have extended themselves far afield to assure themselves of raw materials, a notable example having been Henry Ford, who bought his own blast furnace to make pig iron to change into castings, steel ingots and sheets, and ran soy bean farms as raw material for his own plastic automobile parts.

Such a movement often starts when there is a scarcity of some material. At other times it is inaugurated because of the economies involved, such as the farm cooperative buying organizations.

It will be interesting to watch this newest steel syndicate, with members producing a wide variety of goods as diverse as kitchen stoves, lawn mowers, furniture and advertising signs. There will be many problems to solve, the chief of which might seem to be the lack of homogeneity among members of the syndicate. Will there be "too many cooks" to "spoil the broth"? Will there be charges of unfair distribution of their sheet steel products? Can they make enough varieties of steel to satisfy all, or will they succeed in some clever plan of standardizing on quality and specifications?

Again, can a group of consumers wield the techniques of production commensurate with expert producers, even asuming they hire master minds to run the mills? Have they purchased companies with modern equipment and that compete on a cost basis with the old line steel companies?

On the more positive side, the very diversification among syndicate members may be a blessing in disguise. Thus, when business of the steel furniture maker is slack this may be offset by a boom in advertising signs.

It is an interesting experiment and bears watching by our readers. Let's scrutinize the project five years hence. —H.A.K.

The Materials & Methods Awards

The MATERIALS & METHODS Annual Achievement Awards for outstanding current work in the development, application, and processing of engineering materials will be presented to the 1947 winners at a dinner in Chicago on October 22nd. Their names will be announced, with descriptions of the award-winning achievements, in our next issue. Watch for it!—The Editors

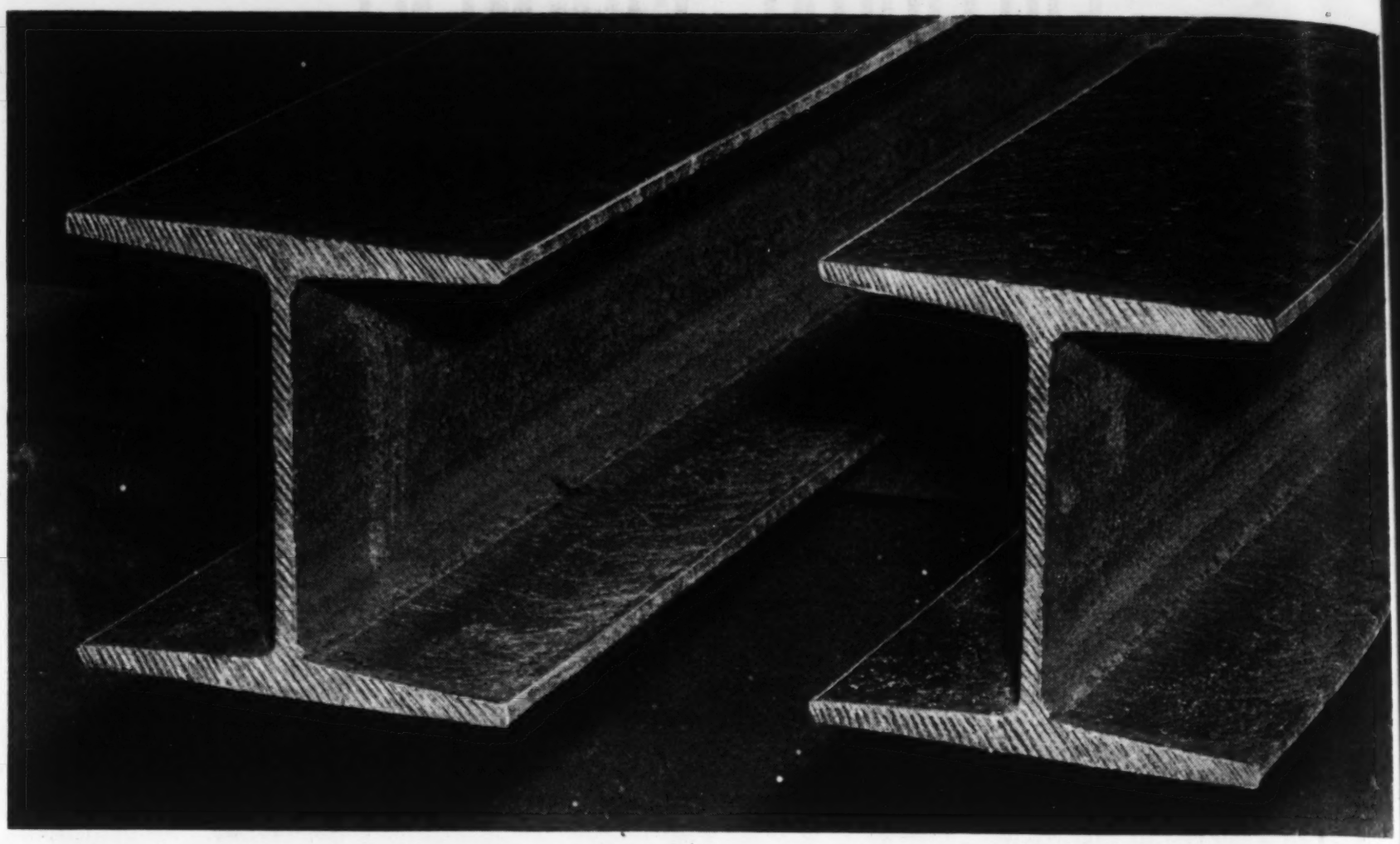
The Customer Decides

The most recent listing of types of stainless steels by the American Iron & Steel Institute is one more indication of how the customer decides which materials he wants. In this list, released in April and published in MATERIALS & METHODS, June 1947, page 123, three types are dropped and two are added. There is no mystery about the moves. The steels that were removed from the standard list were simply not being bought in sufficient quantity to justify their maintenance as standard types, while the new types added were found to be filling a need in industry.

Two ferritic types of stainless steel, AISI 442 and 443, were removed from the list because industry bought only 58 tons of the first mentioned, and not any of the latter type, during the most recent period for which figures are available. To give these figures perspective, the most popular steel in the 400-series was AISI 430, for which industry voted to the tune of 28,665 tons in the same period, the second quarter of the current year. The most heavily purchased of all the stainless types was AISI 302, an 18:8 alloy, with 29,752 tons. AISI 309S, a low carbon variety of Type 309, was likewise omitted from the newest revision of the list of standard types, and for the same reason — insufficient demand.

Of the two steels that join the list, one is a free spinning grade that has been gaining in favor for fabrication of kitchen utensils. This is AISI 305. The second is really a re-issue of a subclassification, a steel for high temperature service formerly designated as 310B, but now officially AISI 314. Each of these types meets a need in industry, and is designated as a standard type for the increased convenience of that arbiter with whom rests the final decision, the customer.

For the buyer that insists upon a nonstandard analysis for a certain purpose, the steel industry will produce on special order, and to specification. Several nonstandard types have been carried in stock for customers for a number of years, and are still in limited demand. For most purposes, however, the standard compositions will meet requirements, and both supply and price will be favorable. —K.R.



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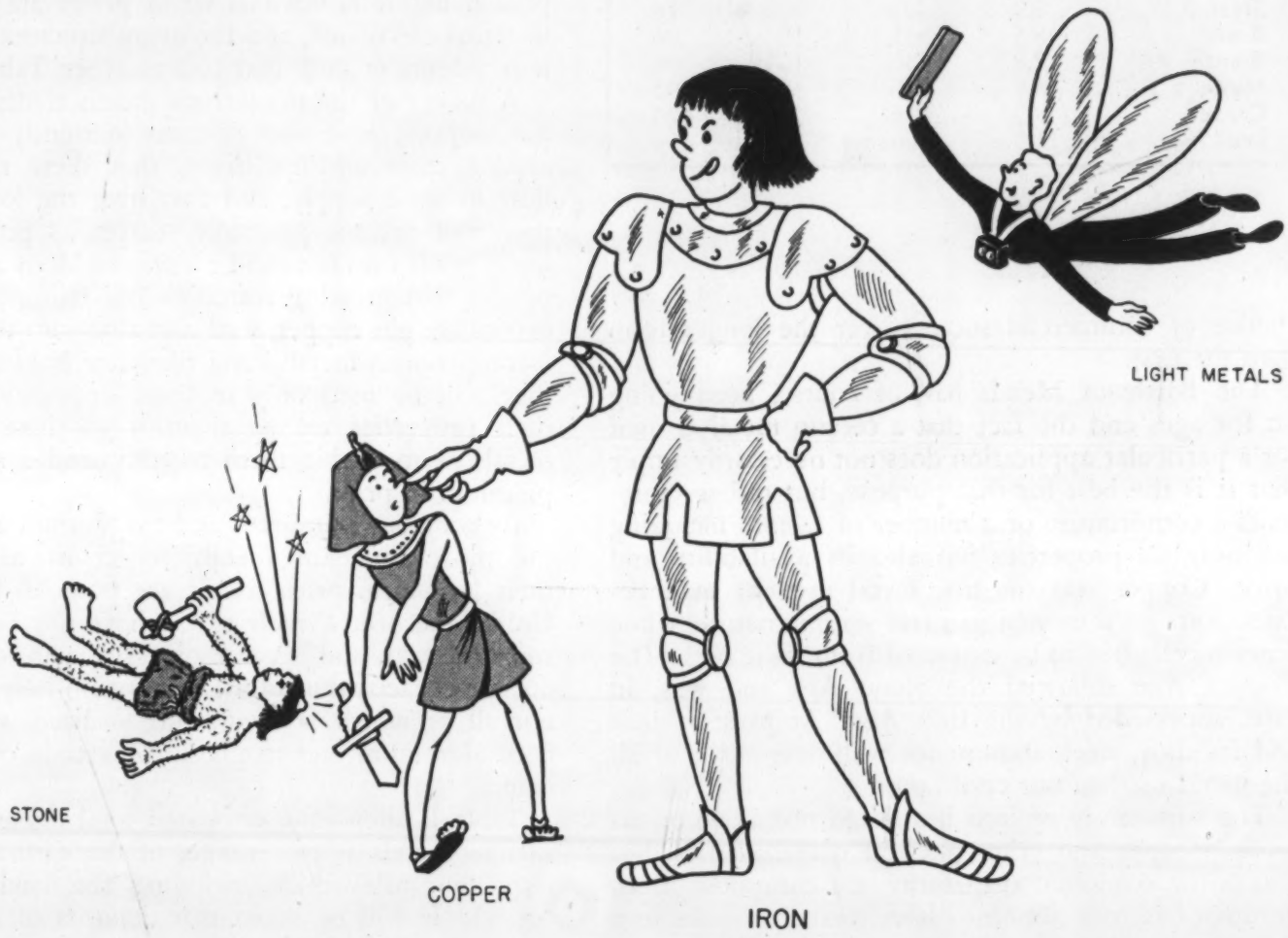


The Supply Outlook for Nonferrous Metals

by JOSEPH P. SHERMAN

Because of the widely divergent supply situation in nonferrous metals, users would do well to reevaluate their materials selections to take into account future availability and cost probabilities.

TRENDS IN SUPPLIES AND PRICES of nonferrous metals should be given consideration secondary only to that of the fundamental suitability of the materials themselves by every designer and engineer who plans to utilize them in his products. Just as metals compete with each other, so do the products made from them. If two competing products are equally well designed and otherwise satisfactory, but one is made from a metal which is gradually becoming more difficult to get and more expensive, while the other is made from a metal that is abundant and cheap, the second product will have a much better

Table I—Relative Costs of Various Metals on Volume Basis

	Specific Gravity	Lb. Per Cu. Ft.	Price Per Lb. (cents)	Price Per Cu. Ft.
Magnesium	1.8	112	20½	$ 23
Aluminum	2.8	175	15	26
Zinc	7.1	443	11	49
Cast iron	7.2	450	4	18
Tin	7.3	456	80	365
Steel	7.9	493	3.3	16
Brass	8.5	531	18	96
Bronze	8.8	550	16½	91
Nickel	8.9	556	35	195
Copper	8.9	556	21½	120
Lead	11.3	706	15	106

chance of commercial success over the longer term than the first.

The Battle of Metals has, of course, been going on for ages and the fact that a certain metal is used for a particular application does not necessarily imply that it is the best for that purpose, but rather represents a compromise of a number of factors including not only its properties but also its availability and price. Copper was the first metal used by man because some of it existed in a free state in nature, while other metals had to be extracted from their ores. The Copper Age followed the Stone Age and was, in turn, superseded by the Iron Age. At present, iron and its alloy, steel, account for well over 90% of all the metal used in our civilization.

The supremacy of iron has rested not alone on its great strength and other physical characteristics, but also on its economic availability and cheapness. Both groups of factors combined have served to make iron the most useful general-purpose metal. If iron were as scarce as gold, notwithstanding its great utility, we would not be living in the Iron Age, but would still be using lumber for most structural purposes.

The proportion of iron is likely to decline as greater quantities of nonferrous metals, particularly aluminum and magnesium, come into use. Although aluminum and magnesium exist in great potential abundance, they are locked up with other elements from which they must be extracted by the use of electricity. They were, therefore, later than many other metals in coming into commercial use. However, consumption of both aluminum and magnesium has been increasing rapidly in recent years and there is every indication that this trend will continue indefinitely in the future.

The light metals have interesting long-term possibilities as substitutes for iron and steel in many applications. Unlike the other nonferrous metals which are more specialized in their uses and also more expensive, aluminum and magnesium fulfill many of the requirements of general-purpose structural materials. Their big advantage, of course, is lightness in weight, but they also have other desirable physical characteristics, including adequate strength for many purposes.

Finally, aluminum and magnesium come closer than any other metals to iron and steel on a price basis. This is not apparent in comparing prices per pound, but it is obvious when prices are compared in terms of volume, and for many structural purposes it is volume or bulk that counts. (See Table I.)

A survey of the nonferrous metals trades indicates that copper, lead and zinc are currently selling at around their all-time highs, that these metals are now in tight supply, and that over the longer term they will become gradually scarcer as progressively lower grade ores have to be worked. Many authorities believe that growing scarcities and rising prices will eventually put copper, lead and zinc into the class of "semi-precious metals" and that, like gold and silver, they will be used only in those applications where their properties are so superior to those of other metals as to enable them to command a substantial premium in price.

By contrast, aluminum and magnesium are among the most abundant metals found in nature, and their long-term price trends are pointed downward. Unlike the others, their prices have not been raised since the war, and because of vast expansion in productive capacity during the war for military purposes, not all of which is now being utilized, supply for both aluminum and magnesium exceeds current demand.

Table II shows the estimated total deposits of the various metals as percentages of the earth's crust (a layer ten miles thick including the land and the ocean). It will be noted that deposits of aluminum are more than 800 times those of copper, 2,000 times those of zinc, and 4,000 times those of lead. Iron ranks next to aluminum in potential supply. A little farther down the list is magnesium, which is 200 times as plentiful as copper, 500 times as plentiful as zinc, and 1,000 times as plentiful as lead.

A glance at the table will show that some of the most abundant metals in the earth's crust have as yet hardly come into commercial use. Examples are calcium, sodium, and potassium. While all of these are in commercial production on a small scale, their uses are highly specialized. One metal, which is fairly plentiful in nature, for which metallurgists are predicting a bright future is titanium.

Of greater practical significance is the fact that the United States is becoming increasingly dependent upon imports to meet our domestic requirements of the older nonferrous metals. According to a recent survey of the Bureau of Mines and Geological Survey, the known reserves of copper, lead and zinc in the United States will not last 25 years at the average rate of consumption prevailing from 1935 to 1944. We have only a 20-year supply of zinc, a 19-year supply of copper and a 10-year supply of lead. Of course, such known reserves may be greatly augmented by future discoveries.

The practical implications of this are obvious. Wherever aluminum or magnesium can be made to do the work of copper, lead or zinc, it will be increasingly advantageous on economic grounds to use one of the light metals. This, of course, has already occurred to some extent. Those in the older metal industries point to the present high prices for their metals and contend that substitutes are already being used wherever feasible. However, they overlook the fact that aluminum and magnesium are relatively young and that research and development work in those metals is being pushed much more aggressively than by their older competitors. As a result, the light metals are being adapted to uses for which they were not previously regarded as suitable.

Consider copper versus aluminum in the electrical trades. Aluminum was being used to an increasing extent in electrical work before the war, principally in the form of conductor cable and industrial busbar and to a lesser extent in conduits, housings, windings, and other miscellaneous uses. On the basis of equal volumes, aluminum is only about 60% as efficient as copper as a conductor of electricity, but its weight ratio is 1 to 3½, so that one pound of aluminum can do the work of more than two pounds of copper in conducting electricity. Compared with copper, aluminum has the advantage of lightness, the disadvantage of bulk.

Up until recently, aluminum was considered to be too bulky for use in house wiring, but new methods of covering aluminum wire have been developed that effect a saving in over-all thickness, thus enabling it to compete with copper. Now the copper people are revising upwards their estimates of the proportion of uses where copper can be displaced by aluminum. This is just one example of how research is gradually extending the circle of uses for the newer metals until they overlap more and more with those of the older metals.

Analysis of the present uses of copper, lead, tin and zinc indicates that there are many places in which other metals or materials can be substituted.

One important outlet for lead, tin and zinc has been in paints and protective coatings. New types of coatings have been developed which utilize other metals, and there has also been a trend toward the use of self-sufficient materials which require no protection from the elements. In pigments, for example, lead has lost some ground to zinc and, in turn, to titanium. Plastics are also being used increasingly to coat metals. Tinplate and galvanized iron may lose some of their markets to steel coated with plastic film. Finally, materials which require no protective coatings are coming into greater use, for example, stainless steel, aluminum, and plastics.

There will also be a tendency in the future to substitute light metals or even plastics for various alloys in structural uses. Brass, an alloy containing

Table II—Content of the "Crust" of the Earth
Including the Lithosphere and the Hydrosphere

	Percentage
Silicon	27.720
Aluminum	8.130
Iron	5.010
Calcium	3.630
Sodium	2.850
Potassium	2.600
Magnesium	2.090
Titanium	0.630
Manganese	0.100
Barium	0.050
Chromium	0.037
Zirconium	0.026
Nickel	0.020
Vanadium	0.017
Gerium and Yttrium	0.015
Copper	0.010
Tungsten	0.005
Lithium	0.004
Zinc	0.004
Columbium and Tantalum	0.003
Hafnium	0.003
Lead	0.002
Cobalt	0.001
Boron	0.001
Beryllium	0.001
Molybdenum	0.0001
Arsenic	0.0001
Tin	0.0001
Mercury	0.00001
Silver	0.000001
Selenium	0.000001
Gold*	0.0000001

**This is equivalent to 24,500,000,000 tons of gold.*

Source: The Journal of the Franklin Institute, *Vol. 239, No. 6, June 1945, based in part on data of the U. S. Geological Survey.*

on the average about 70% copper and 30% zinc, has in the past accounted for a substantial proportion of the total consumption of those metals. Another example is zinc die castings.

The following summaries of the present demand-supply relationships for the leading nonferrous metals and their principal uses were obtained directly from the different metal industries.

Copper

Total consumptive requirements for copper in the United States are running at a monthly rate of 120,000 tons, which is equivalent to 1,440,000 tons a year. Of the monthly total of 120,000 tons, we are getting 90,000 tons from domestic production, both primary and scrap, leaving 30,000 tons to be supplied from imports and withdrawals from stockpiles. Primary production of copper is running at about 75,000 tons a month and secondary production at about 15,000 tons. The situation in copper is now very tight and there is no doubt that the major consuming industries could use more if they could get it.

Most important market for copper has been the

electrical trades, which, directly and indirectly, have accounted for over 50% of total consumption. Many other industries, including the automobile and the building, have also been among the large users of copper. Of particular significance has been the increasing use of copper by the building industry in recent years.

It is generally agreed that copper will maintain most of its present markets, at least in the near future, although increasing competition is expected from light metals and plastics, particularly from aluminum both in the electrical industries and as a substitute for brass. On the other hand, copper may gain some new markets of its own. The fabricating end of the industry is aggressively promoting the use of copper tubing for radiant heating installations, which are reported to be taking increasing quantities of the red metal. New types of copper alloys including those with beryllium, silicon bronze and manganese bronze have interesting possibilities.

Lead

Consumption of lead in 1947 will exceed 1,000,000 tons, according to the Lead Industries Association. Four largest uses and estimated amounts of lead they will take are as follows: storage batteries, 300,000 tons; electric cable, 200,000 tons; construction and maintenance (including lead used in paint), 175,000 tons; and ethyl gasoline, 60,000 tons. In addition, it is estimated that other uses will require the following amounts of lead: X-ray protection and use in chemical industry, 50,000 tons; solder, 50,000 tons; ammunition, 50,000 tons; bearing metals, 40,000 tons; copper alloys, 35,000 tons; printing, 30,000 tons; and insecticides, 20,000 tons.

Against an anticipated demand for over 1,000,000 tons of lead in 1947, domestic mine production is expected to supply 450,000 tons, and scrap may yield 350,000 tons, or a total of 800,000 tons. The difference of over 200,000 tons will have to be made up by imports from Canada, Mexico, Peru, and Australia. Imports of lead for the first four months of this year were 75,000 tons, indicating a total of 225,000 tons for the full year, compared with 156,000 tons in 1946.

In its largest markets, lead is expected to hold its own against competition. The industry claims that there is no generally satisfactory substitute for lead in such uses as storage batteries, cable, exterior paint, and ethyl gasoline. However, considerable research effort outside the industry is being directed toward the development of substitutes. For example, it is reported that the oil companies are attempting to find an alternative to the use of lead in ethyl gasoline, in case their supply of lead should be shut off because of large requirements for the metal in atomic power plants.

Hundreds of tons of lead were used in the Oak Ridge, Tenn., and Hanford Wash., atomic bomb plants. Lead has the unusual ability to shield living beings from dangerous radiation of all kinds. It is claimed that 7 in. of lead will give as much protection from dangerous radiation as 60 in. of concrete. Lead is used both in the form of wall sections and also of bricks which can be moved about as desired.

Of course, the industry has no way of telling how much lead may be used in connection with atomic projects of one kind or another. It may be a relatively small amount for use in scientific laboratories and movable containers, or it may become a very sizable amount, if atomic energy goes into large-scale commercial development. Some informed sources believe that lead will be used for movable protection, but that concrete will be employed for stationary protection.

Zinc

Consumption of zinc in 1947 is estimated at 900,000 tons. Of the total, galvanizing will take about 342,000 tons; zinc base alloys, 258,000 tons; brass, 180,000 tons; rolled products, 96,000 tons; and other uses, 25,000 tons. These estimates are based on United States Bureau of Mines consumption data for the first few months of 1947. Demand for zinc this year has been running at an even higher rate than last year and increases are being shown for galvanizing, for die castings, and for brass.

Domestic shipments of zinc for the first five months of 1947 totaled about 325,000 tons, which would be at the annual rate of 780,000 tons. Exports for the first five months aggregated 49,000 tons, which would be at the annual rate of 118,000 tons. Thus, the total indicated annual rate for domestic shipments plus exports would be close to 900,000 tons.

Domestic production of slab zinc for the first five months of 1947 was about 366,000 tons. During the same five months, we imported about 37,000 tons of slab zinc. The total indicated supply of slab zinc for the five months period was 403,000 tons, which would work out to an annual rate of 968,000 tons. It is interesting that the ratio of imports to domestic production thus far in 1947 has been about 1 to 10.

As for competition from other materials, the zinc industry expects to hold on to its most important markets. It points out that the largest single use of zinc is in galvanizing or coating steel with zinc to protect it from corrosion and that nothing else has yet been found that is as efficient or cheap as zinc for coatings. It is cheaper to dip steel in zinc than it is to paint it, due to the savings in labor and other costs. Of course, aluminum sheeting has already displaced considerable galvanized steel sheeting on farm buildings, as a result of shortages. However, the zinc industry expects to recover a major share of its losses

when normal supplies become available again.

Some further competitive losses of zinc are expected in die casting, which has shown remarkable growth and now constitutes the second largest market for the metal. Increasing competition is expected from aluminum and magnesium, which are considerably lighter in weight than zinc, and which came into large use during the war for aircraft parts. The zinc industry, however, claims that the die casting field has become accustomed to zinc, which machines better, lasts longer, and takes a better finish than aluminum, the principal competitor of zinc.

Brass, third largest market for zinc, is also expected to have increasing competition from light metals and plastics but this will probably be a slow development. The industry points to the popularity of brass in most of its uses, its easy machinability, and the fact that metal fabricators like to work with brass and will be reluctant to change.

Aluminum and Magnesium

In contrast with copper, lead and zinc, productive capacity for both aluminum and magnesium is well in excess of current consumptive requirements. Productive capacity for aluminum is about 1¼ billion lb. per year. Consumption of aluminum in 1946 was between 800,000,000 and 900,000,000 lb. It is estimated that aluminum consumption for the full year 1947 will run close to 1 billion lb.

Production of magnesium is, of course, much smaller than that of aluminum, but there is a relatively greater excess of productive capacity. Total productive capacity for magnesium is 212,000,000 lb. a year. Current consumption of magnesium is about 1,500,000 lb. a month, which would indicate an annual rate of 18,000,000 lb. Total consumption for 1947 is estimated at 25,000,000 lb.

New uses are constantly being found for both aluminum and magnesium. Aluminum Company of America reports a total of 3,500 uses for aluminum. The Magnesium Association states that 71 new applications have been found for magnesium since the end of the war. Markets for aluminum have undergone revolutionary changes compared with the prewar period. Biggest market for aluminum in 1939 was in transportation, whereas in 1946 it was in building construction. An important new development has been the use of sheet aluminum for roofing, particularly for farm buildings. It is estimated that approximately 400,000 farm buildings in the Southwest are covered with aluminum roofing. Aluminum is making a real bid in the construction field and the number of applications is continuously increasing.

Tin

The outlook for tin is probably less promising than for any other nonferrous metal. Tin has been subject to declining tendencies in a number of its markets for a period of years, and this trend will probably continue. Tin has been largely displaced in foil and collapsible tubes by aluminum. In various other uses, it has been losing ground to other metals. The war taught us how to economize in the use of tin, since it is a metal for which we are dependent on foreign supplies.

Most important remaining use of tin is, of course, in making tinplate for metal containers. New methods of electroplating have been developed that take only one-third to one-half of the tin required to coat a given surface under the old hot-dipping processes. There is little doubt that we can get along with much less tin than we have used in the past.

Table III—Recent U. S. Production Peaks of Metal in Primary Form

	Net Tons	Year
Steel (Ingots)	89,641,600	1944
Merchant Pig Iron	9,138,594	1943
Total Iron and Steel	98,780,194	
Nonferrous Metals		
Copper	1,521,049	1943
Aluminum	1,234,140	1943
Zinc	990,524	1943
Lead	634,888	1941
Magnesium	183,584	1943
Tin	79,409	1945
Total Nonferrous Metals	4,643,594	

Source: *American Iron & Steel Institute*

Conclusions

The nonferrous metals may be expected gradually to increase their present proportion of less than 10% of total metal consumption, largely as a result of the growing use of aluminum and magnesium.

For metals generally the long-term price trend is upward, as less accessible deposits and lower grade ores have to be worked. This is particularly true for copper, lead and zinc, which because of growing scarcities and rising prices will be reserved for special uses. On the other hand, the potential abundance of aluminum and magnesium indicates a continuation of their downward price trends. A widening price spread between the older and newer nonferrous metals should result in a gradual shift in use from the former to the latter.

Over the near term, economic conditions rather than fundamental considerations of supply will determine the price trends for the nonferrous metals. Lower demand for copper, lead and zinc resulting from a possible business recession might bring about considerably lower prices for these metals even in the face of growing scarcities. However, a sharp reduction in prices might well be of a temporary nature.

A calculated disregard for theories concerning the heating of nitrided steels resulted in a highly satisfactory procedure for economically producing formed parts with high hardness values.

Nitrided Steel Hot Formed After Heat Treatment

by **JACK FRAZIER,** *Metallurgical Engineer, Jack & Heintz Precision Industries, Inc.*

UNDER THE STRESS of wartime urgency many industrial problems were solved in days that in less strenuous times would have permitted allotting months to their study. An unfortunate angle of much of this high-pressure development work is that useable solutions were obtained for problems without there being time to study carefully why the method produced a solution. As a result, the theory upon which the work was based was not developed, and a part of the possible value of the work was lost.

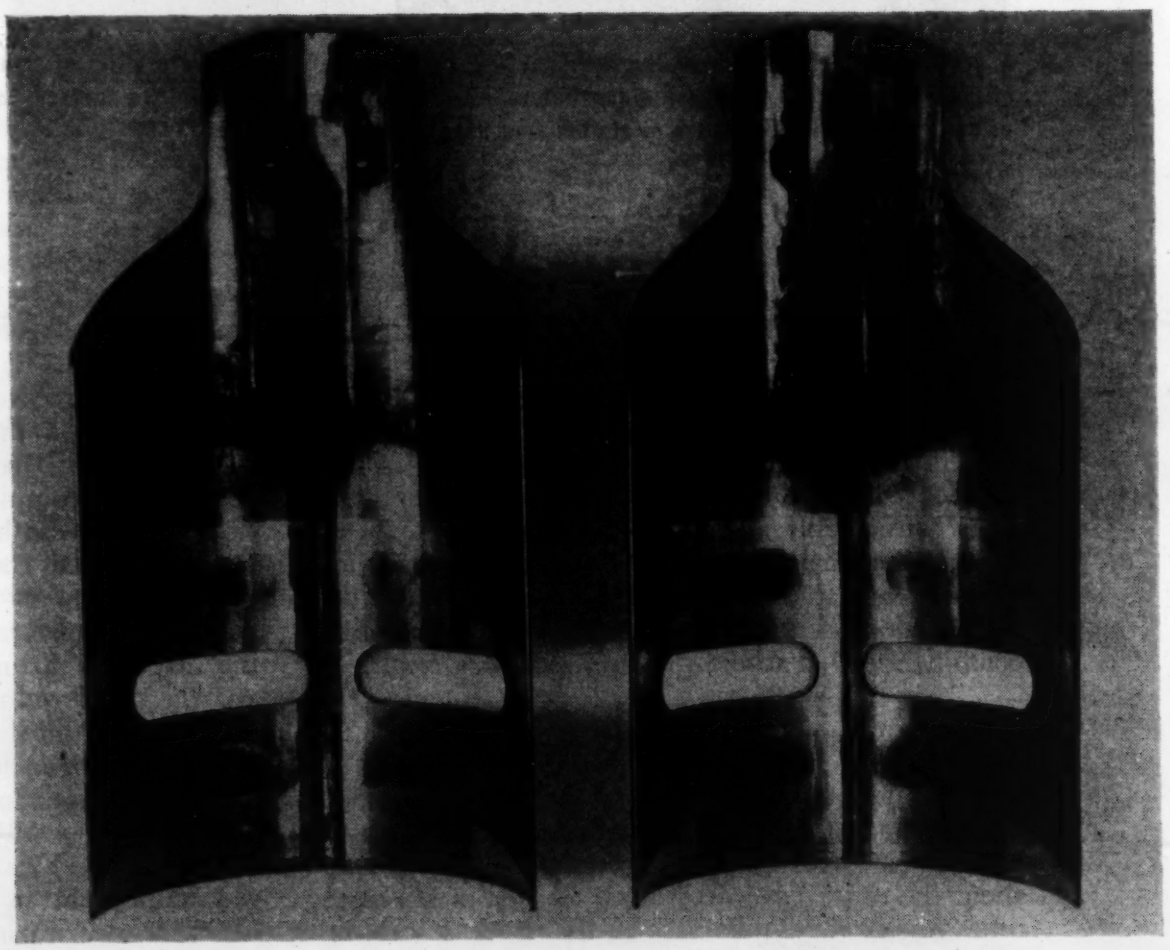
Despite this inability to realize the full value from them, the methods developed under pressure have in their favor the important point that they give results. This is the paramount criterion of all development work from a production engineering standpoint.

One such development was the evolution of a new series of operations upon a nitriding steel at Jack & Heintz Precision Industries, Inc. The results obtained contradict several of the accepted ideas about processing a nitriding steel, and no theory has been developed to explain why these results were obtained, nor has any attempt been made to discredit generally accepted procedures. Results are purely empirical.

It was decided to make the sleeve valves of an internal combustion engine of nitrided steel so as to have the necessary hardness in this engine part for long and hard service. The steels designated as Nitralloy 135, (Type G) and Nitralloy 125, (Type H) were selected for tests. Although both were suitable, it was finally decided to use Type H. These steels have the following compositions:

Type H	*Constituent*	*Type G*
0.20-0.30	Carbon	0.30-0.40
0.40-0.60	Manganese	0.40-0.60
0.30 max.	Silicon	0.30 max.
0.90-1.40	Chromium	0.90-1.40
0.90-1.40	Aluminum	0.90-1.40
0.15-0.25	Molybdenum	0.15-0.25

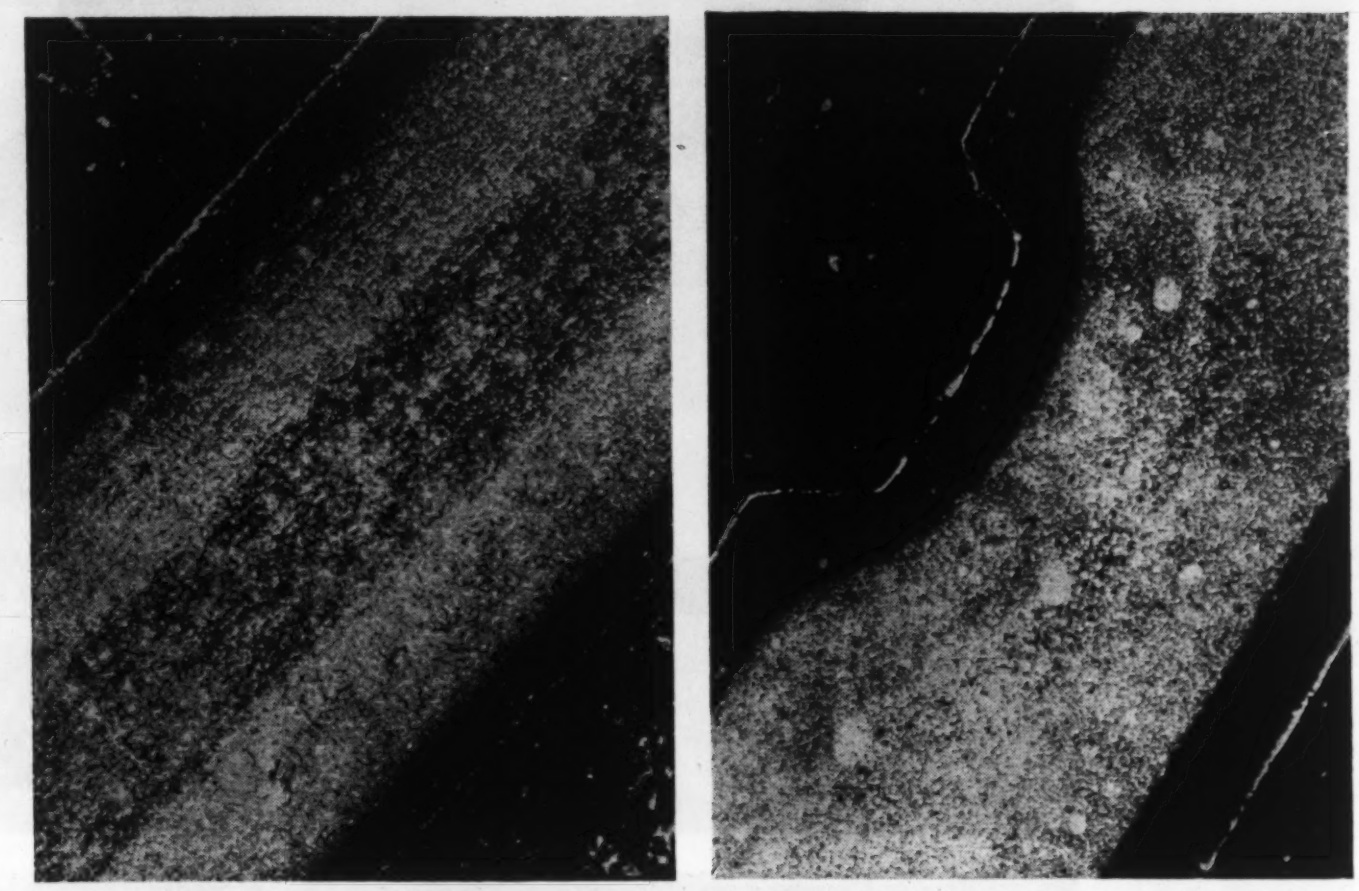
A case depth of 0.008 in. was fixed upon so that inside and outside finishing of the valve would leave a case 0.006-in. thick. The design required a thickness of 0.0455 in. in the valve sleeve, with a tolerance of plus or minus 0.005 in. The first move to assure a high rate of production upon the sleeves was made outside the plant, when Allegheny-Ludlum agreed to produce a special strip, with a grind pass after



Two pairs of valves made of Type H Nitralloy steel that have been run for 1,000 hr. each. There is no appreciable surface wear.

annealing and just before the final cold roll to 0.050 in. This produced a strip of Type H Nitralloy steel, down to size, and with no decarburized zone, so that it was ready for immediate forming operations at the Jack & Heintz plant.

In laying out the sequence of operations, several of the accepted concepts about nitriding raised an obstacle. A desirable sequence would have been as follows: (1) blank; (2) cold form; (3) nitride; (4) finish hot form; (5) inside hone; (6) outside finish; (7) finish condition. This would have the advantage of giving the sleeves their final form after all heat treatments, so that distortion would be eliminated. A hot finish forming operation would be satisfactory



A section through the whole thickness of the valve (left) shows uniformity of case depth. The dimples (right) to assist oil flow are made before nitriding. The case follows the surface contour. (Magnification of both samples is 50X and a nital etch was used.)

upon the hardened pieces if final hardness could be held to the required 65 to 67 Rockwell C.

In view of the generally accepted prohibition against heating of nitrided parts above 1200 F, this sequence seemed impossible. Cold forming of the nitrided parts was out of the question, and temperatures considerably above 1200 F would be required to hot form the sleeves without danger of cracking. An intensive study of the nitriding process and the final hot form was begun, in the hope of finding some combination that would give a satisfactory result.

Combined Forming and Pressure Quenching

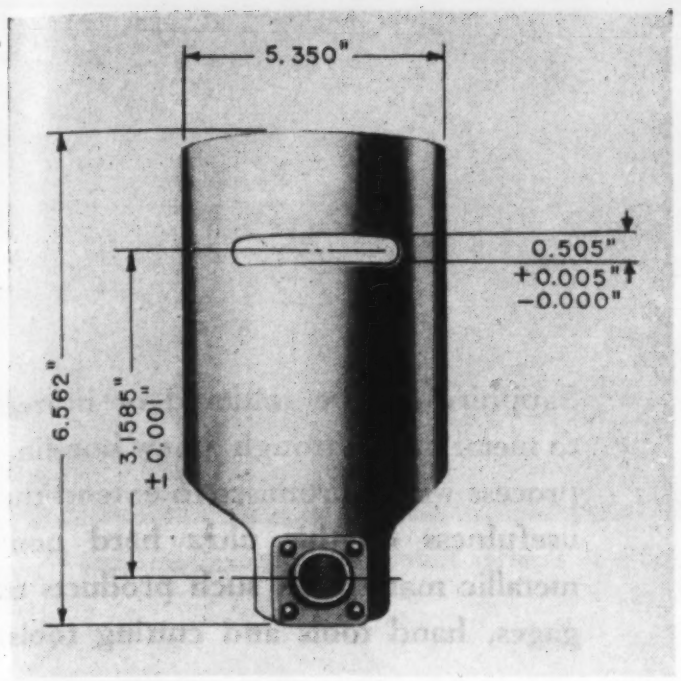
The solution was finally reached in a combined forming and pressure quenching operation, for which a special die was developed. Some interesting facts about the nitriding process were learned at the same time. One of these was that, for this work, a sorbitizing process before nitriding was not necessary. Another was that a completely satisfactory case could be produced in considerably less than the time usually recommended, despite the high ratio of area to weight in these sleeves. Sorbitizing, or any similar protracted treatment at elevated temperatures, was not feasible after centers on the valve sleeve were established in the blanking and cold forming operations.

The blanking operation presented no problem. A die was made to cut the shape of the valve, and to punch the holes for the ports and for the rivets at the same time. After making approximately a thousand check tests, it was determined that metal movement which occurred during hot forming was consistent enough to make allowance for any such changes in the blanking die. Cold forming was also a routine procedure, accomplished in two steps. A first operation gave the flat blank a partial form, and a second step completed the semi-cylindrical shape. It was found that a slight overforming here was advantageous in the final forming operation. The partial forming helped to maintain the center line of the valve, and the overforming in the second step largely compensated for the slight springback during nitriding.

Nitriding was done in Leeds Northrup furnaces, with the temperature closely held at 975 to 980 F, the ammonia at 30% dissociation, and with the time at first about 15 hr. After a little experimentation, it was found that an effective case depth of 0.006 to 0.008 in. was obtained in 9 hr. with the H alloy, and in 4 hr. with the G alloy. Two hours were allowed for heating and cooling before and after actual nitriding. Rockwell hardnesses, as converted from the superficial scale, were 68 to 70 C.

The reason for the rapid development of the hard case in the alloy strip, without the usual preliminary sorbitizing treatment, was unknown, and there was no time for a theoretical study. The entire development of the nitrided steel sleeves was accomplished within about a month.

Closely related to the nitriding was the problem of



Tolerances on the nitrided steel part are close. Dimensions are laid out on the flat blank, with corrections to bring them to those shown in the finished form.

the final hot forming. It was required to heat the sleeves to a temperature high enough to permit their being formed without any danger of cracking, and without any significant loss of hardness in the pieces. The solution finally reached required close control of temperature, pressure, and time, and involved the use of a hot forming die developed to quench as it formed.

The sleeves were heated in a controlled atmosphere furnace to 1950 F, with a maximum soaking time of 3 min. They were then removed, one at a time, and each was immediately placed in the lower male half of a forming die, 30 tons pressure applied by the upper female half, and the pressure was maintained for 20 sec. The sleeve was then removed, checked on a gage, and passed to the surfacing operations. Hardness readings upon the finished pieces all fell within the range that, converted to Rockwell C, was required, *i.e.*, 65 to 67.

The rate of heat withdrawal was critical, and all factors had to be closely controlled in view of the thinness of the metal involved. The dies were water-cooled. Prompt handling of the sleeves as they left the furnace eliminated the air cooling that is always a danger with light work, so that the cooling was started from a temperature quite close to furnace heat. The design of the die provided against uneven cooling, or precooling of the work before the closing of the dies, by providing disappearing supports about 2 in. long at each side of the die. These supports held the sleeve out of contact with the cooled portion of the die, but were forced down as the two halves of the die closed.

It was found that the 20-sec. period during which the dies remained in the closed position must be held very accurately. When the dies were permitted to remain closed for a slightly longer period, even 5 sec. more, the sleeve was curled, and fitted tightly on the gage. Shortening the period by a few seconds caused the part to come out of the dies warm, and the form was not held. At exactly the 20-sec. holding period the sleeve came out of the dies at room temperature.

Pressure was critical also. Thirty tons gave perfect results. Decreasing the die pressure to 20 tons caused the sleeve to be underformed, while at 35 tons cracking began to develop. The temperature of 1950 F was required to avoid cracking also. When the hot forming operation was tried with the furnaces at 1850 F, cracks showed in the surface of the sleeves.

An inside honing and an outside superfinishing completed the machining of the valve sleeves. Valve surfaces were finished to 15 rms. and placed in engines without any further conditioning. The finished valves were remarkably stable geometrically under rough usage and handling. One test which all valves successfully passed was that of bending them in a vise to approximately 50% of their original diameter without cracking and on the springback, they return to within 0.0005-in. of their original diameter.

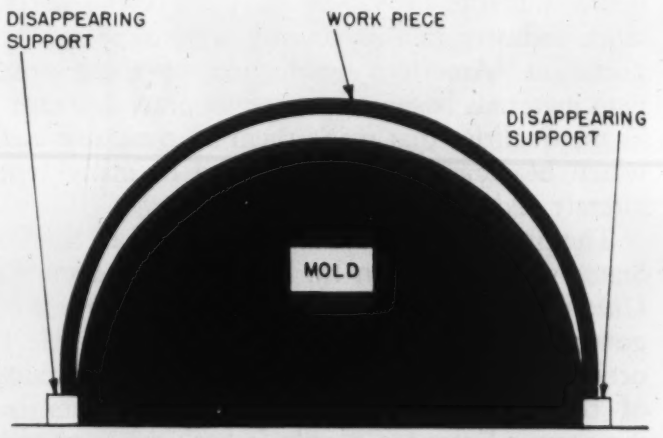
Excellent Performance of Parts

The nitrided sleeves gave excellent performances in service. Tests made upon motors under controlled conditions gave the following results:

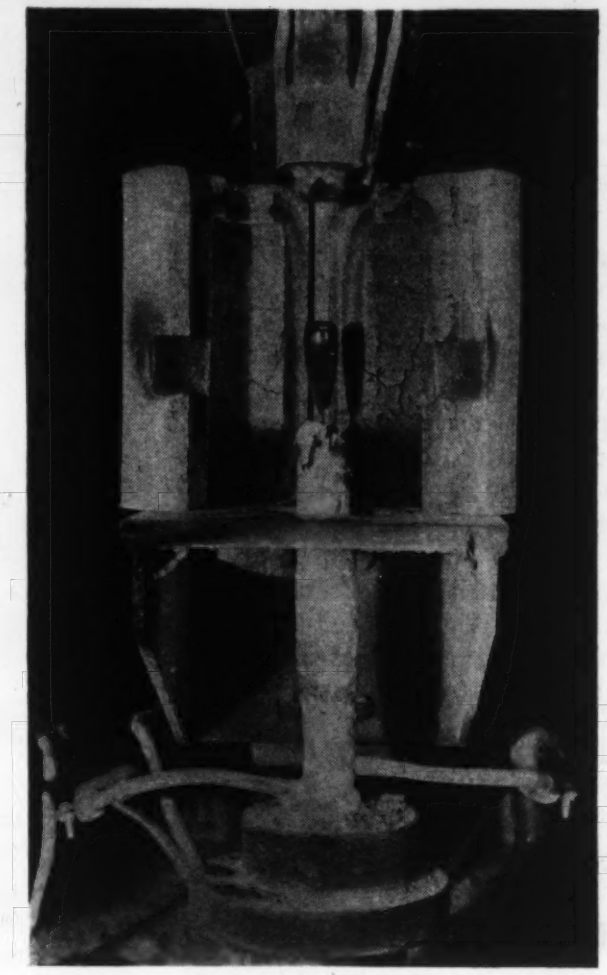
	Wear
After 500-hr. running	less than 0.0005 in.
After 1000-hr. running	less than 0.0005 in.

Although specifications were close, the process gave very satisfactory results from an inspectional standpoint. During the entire run of several thousand production valves, only 2% of the pieces varied noticeably from the nominal dimensions. No pieces were rejected for hardness.

It is believed that this process has many possibilities where the fabrication of formed parts with thin sections is a problem, especially if such parts must possess dimensional stability, high hardness and high wear resistance.



Two disappearing supports with light spring action to permit retraction immediately as the dies close, hold the hot valve away from the cold die until the forming-chilling operation starts.



Synthetic sapphire is produced in oxyhydrogen furnaces. Here a boule of newly formed sapphire is ready to be removed from the furnace.

Sapphire can be soldered or brazed to metal parts through a new bonding process which promises to extend the usefulness of this ultra hard nonmetallic material in such products as gages, hand tools and cutting tools.

Bonding Sapphire to Metal

by T. C. DU MOND, *Managing Editor,* MATERIALS & METHODS

IN THE SEARCH FOR DURABILITY, low friction properties, and nongalling qualities needed for the tiny bearings for fine watches and clocks, the synthetic gem materials of the corundum type have been regarded as the ultimate for many years. Synthetic ruby and sapphire was produced in Europe in substantial quantity before 1939, and the needs of the watch and clock industry in this country were supplied by importation. American production of these synthetic gem materials began as a wartime necessity, especially as the qualities that made them so generally used for watch bearings dictated their use in many types of aircraft and precision instruments.

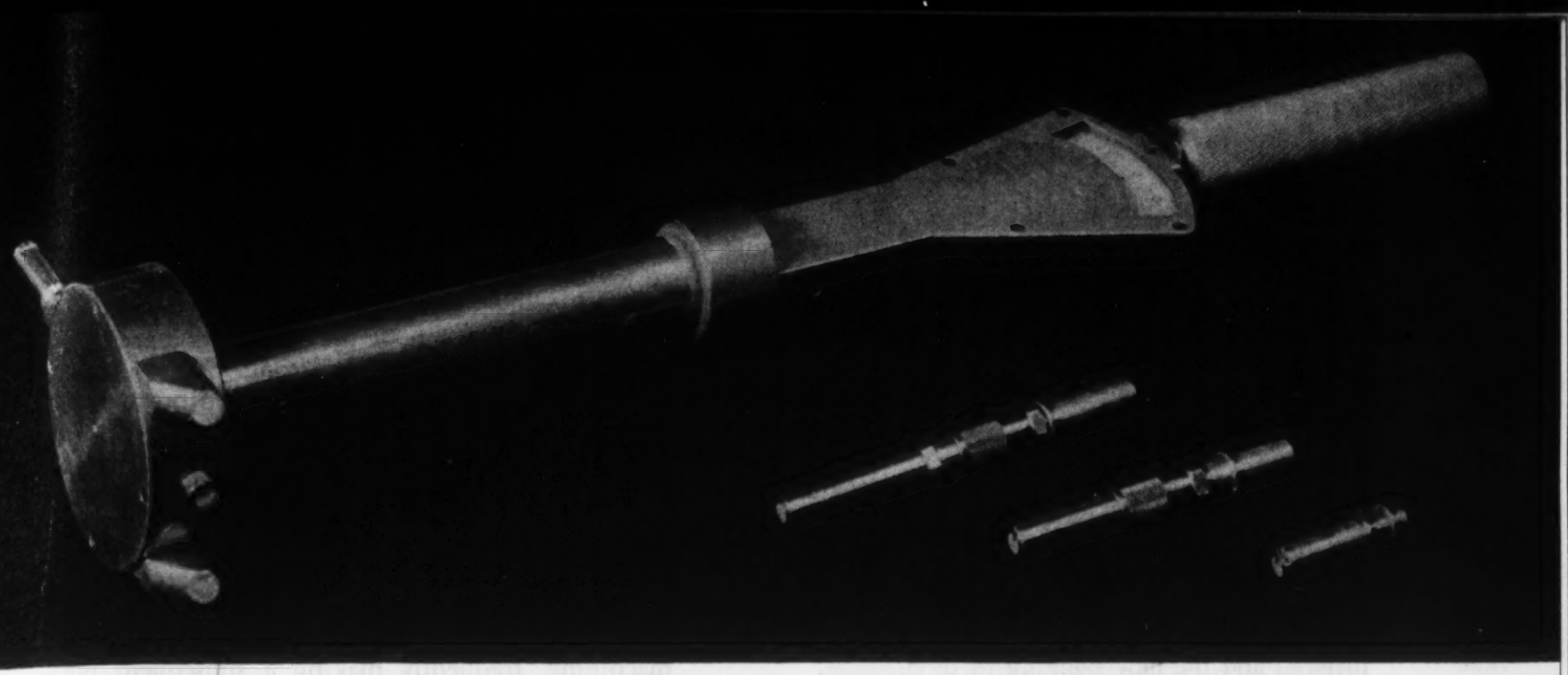
The production of synthetic sapphire in the United States was undertaken by Linde Air Products Co. of Union Carbide & Carbon Corp. at the request of the government. Starting from scratch, Linde Air Products developed new techniques for the production of the fused alumina gem materials, outstripping the prewar European supply in both quantity and size range.

For the first time, sapphire material was made available in rods up to 4 ft. in length, and in shorter pieces of about ¾-in. dia. Sapphire rods could be used in small plug gages. Bearings of ½-in. dia. could be produced from solid material. Industrial possibilities were considerably widened.

In the process developed by Linde, a fine stream of the spectrographically pure aluminum oxide, with very small amounts of other oxides added if colored gems are desired, is run onto a rotating rod of the sapphire material in a small oxyhydrogen furnace. The powdered alumina is sintered to the sapphire core, and the new mass is gradually built up. By withdrawing the rod slowly at the bottom of the furnace, the accumulations made at the top of the rod add to its length, and it can be drawn out to any length up to the maximum vertical travel provided for.

American techniques have done wonders in the production of synthetic sapphire for industrial use and the price has been reduced to the point that use of the material in such relatively large parts as plug and ring gages, wire dies and burnishing tools becomes economical.

It was apparent to officials of Sapphire Products Div., Elgin National Watch Co., that a process that would make possible the positive bonding of sapphire



Sapphire tipping on the contact surfaces of a Swedish gage for internal diameters will prevent wear at these points.

to metal would greatly expand the usefulness of this material. It would then be possible to tip the members of steel gages with sapphire, as they are sometimes tipped with carbides. Not only would a considerable material cost saving result, but the combining of steel, easily machinable and formable hot or cold, with the extremely hard sapphire would permit its use for tools for which the sapphire alone could not be fashioned to the required shape.

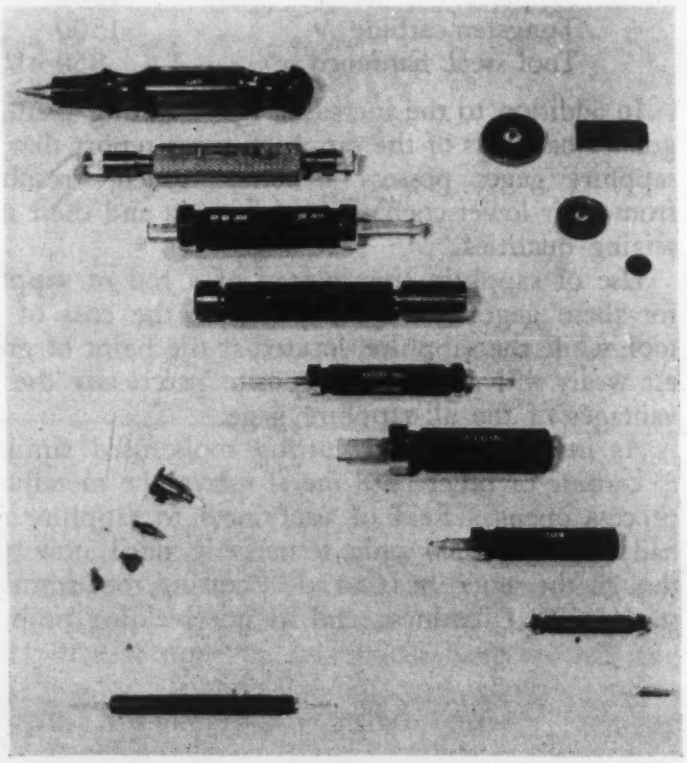
Intensive research at Sapphire Products Div. and at Armour Research Foundation has produced a process that makes possible the fusion bonding of a metal layer to the surface of sapphire, and the subsequent joining of this metallized sapphire to any metallic surface to which soldering can be accomplished. Sapphire tips can now be soldered to the spindle and anvil of micrometer-type gages; sapphire inserts can be fastened to carbon steel shanks of cutting tools; sapphire tips can be applied to the ends of positioning fingers on automatic machinery, and many other fields have been opened to the hard gem material.

The new process, for which patent application has been made, consists of fusing a copper-base alloy to the surface of the sapphire material, effecting the necessary original metallizing of the alumina. The layer of copper-base alloy applied is thin—just sufficient to provide a surface that can be bonded to other metallics by such metal-to-metal joining methods as brazing or soldering. Another requirement of the alloy is that it have a coefficient of thermal expansion fairly close to that of the sapphire material, to minimize the stresses that would result in the composite during temperature changes. The alloy used has a coefficient between those of the sapphire and of the steel that usually forms the base material in tools and implements.

Bond strength has been determined in tests of various composite pieces, and is of the order of 9,000 psi. As the bond will be in compression for most types of uses of the sapphire-faced parts, this tensile strength is ample.

In making a sapphire-tipped tool or other device, the sapphire is first formed by grinding or sawing, to be the bonding method used. The metallized is then fused onto the face of the formed sapphire that is to be joined to the metallic base. Depending upon the shape of the piece and other conditions, especially the accuracy required in various dimensions, the metal base or body can be formed before or after joining to the sapphire tip. The soldering or brazing operation is performed similarly to the bonding of carbide or other tool inserts to the carbon steel tool shanks by means of a gas torch or by induction heating.

When bonding the metallized sapphire to a metal tool base, the base metal is first tinned if soldering is or both, using diamond dust. The copper-base alloy



Tools using sapphire tips include plug gages, ring gages, dial indicator contact points and a hand burnishing tool.

layer of the sapphire insert may then be tinned, using care to avoid thermal shock. The heated sapphire should not be touched with cold tongs, but the tongs should be heated if they are to be used for handling the sapphire, or for holding it in contact with the base while the solder cools. Silver brazing follows the usual procedure, with the same precaution about thermal shock.

Some of the applications already made for the new process of sapphire tipping are in the facing of poising tools, tipping of plug gages, and for cutting inserts in cutoff and other tools. These illustrate how some of the advantages of sapphire can be conferred upon a tool by the use of a small amount of hard material and the new bonding method.

The poising tool is a very small vise used to hold watch parts while checking their balance and accuracy. The shaft of the balance wheel is supported by its tips between the jaws of the poising tool, permitting the wheel to be spun freely. Facing the jaws with sapphire makes possible the same low friction properties for testing that are obtained by using sapphire bearings in the watch movement.

Use of sapphire rods for plug gages was a wartime development, and service has been sufficiently long to obtain some comparative results for sapphire gages, carbide gages and steel gages. The advantage in service life lies with the sapphire gages, one user reporting a sapphire gage giving 7000 times the life of a steel gage and 1000 times the life of a carbide gage. It is safe to generalize from the results that the life of a sapphire gage will be hundreds of times that of a steel gage or a carbide gage.

This is to be expected from a comparison of the Knoop hardness values of the materials. These are, approximately:

Sapphire	1900
Tungsten carbide	1500
Tool steel, hardened	850

In addition to the increased life resulting from the greater hardness of the sapphire, users report that the sapphire gages possess a better "touch," resulting from their lower coefficient of friction and their non-seizing qualities.

Use of sapphire tips instead of a rod of sapphire for these gages will greatly reduce the cost of the tool, while the sapphire, located at the point of greatest wear, will give the composite practically the advantages of the all-sapphire gage.

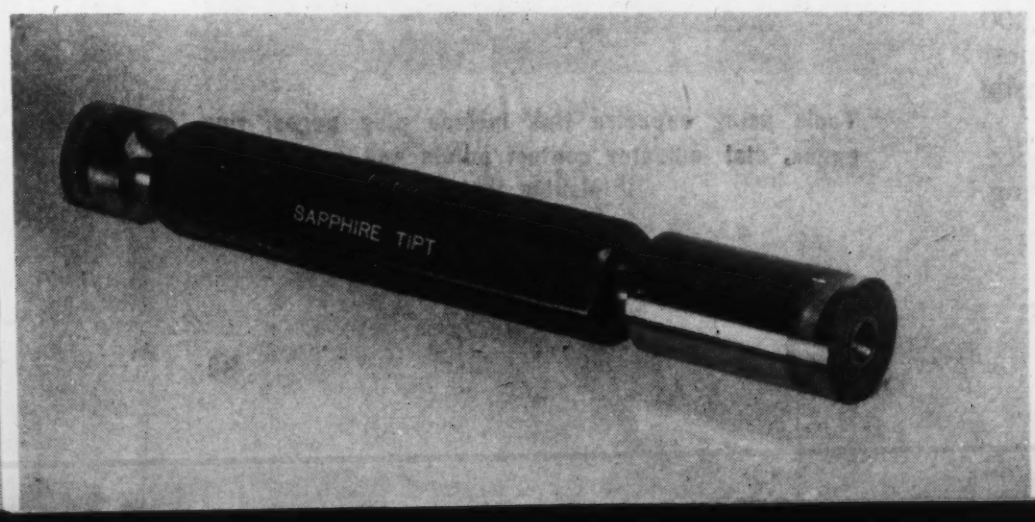
As inserts for metal cutting tools, used similarly to carbide or other hard metal inlays, the metallizing process opens a field of usefulness to sapphire that had been explored only tentatively until now. Although the sapphire is an ideal cutting tool from the standpoint of hardness, and its non-welding property makes for cleaner cutting, the material is too brittle to withstand shock loading. The new bonding process makes possible the use of sapphire-tipped cutting tools in which much of the load is compression, in which the material is amply strong. Some success has been found with the use of sapphire-tipped tools for cutting hard metals, such as steel, but they have been used with considerable success in machining many of the soft metals, such as silver, gold, copper and lead, and for cutting some of the plastics, especially thermoplastics.

The non-seizing, non-welding properties of sapphire cause it to machine the soft metals with particular ease, and to produce a high finish with ordinary machining, frequently making a subsequent polishing operation unnecessary. Freedom from burring is another advantage that has been reported. When used as a burnishing tool, it produces a high finish on thermoplastic resins. It is being used to size and burnish the bearing surfaces of powdered metal bearings including the oil-impregnated copper bearings of the self-lubricating type. In this case, it has been found that the sapphire tool sizes and smooths the surfaces of the bearings without decreasing their lubricating properties.

The composite material was studied in connection with the gas turbine, where materials capable of withstanding high temperatures are needed to increase the efficiency of the plant. A sapphire-faced metal would offer interesting possibilities for blading. While the sapphire was quite capable of withstanding the high temperatures of operation, it was shattered by the violent changes of temperature required by the tests.

Cut-off tools with a sapphire inlay have been found to be especially successful for use with the soft metals. These are used in the small sizes with power machinery. Burnishing of oil-impregnated bearings is done with a sapphire rod, with two flattened sides diametrically opposite to permit lubrication during the work. This operation is done in a small drill press. About 0.0004-in. of stock is moved in smoothing the bearing surfaces. Other burnishing operations, such as hand burnishing of carbide dies, or breaking wire edges on these dies, also employ sapphire tools.

The new process for bonding sapphire to metal is making possible the more economical use of the hard nonmetallic material, and is opening the field of metal cutting by creating a composite of greater strength than the hard material alone. Combining the high temperature resistance and extremely high hardness of the sapphire with the strength and machinability of metal will give industry a new composite that it should find useful in many more ways as its value becomes known.



Here can be seen the points where sapphire tips are bonded to the steel body of a plug gage.

Although die casting and stamping are not often thought of as competitive methods, there are some parts on which either method could be used. Given here are some examples of where die castings have proved more economical.

Fig. 1—The fact that this part has a tapered section and ears resulted in its being produced as a die casting.

When Parts Should Be Die Castings Rather Than Stampings

by HERBERT CHASE

ALL EXPERIENCED DESIGNERS of metal components to be manufactured in substantial quantities are well aware of the advantages and economies available in stampings. However, when a part is of such a nature that it can be made either by stamping or by die casting, and when service requirements are such that the properties of steel are not required, it is frequently more economical and may serve its purpose better in the latter form. This is sometimes true even when the stamping can be made with a simple blanking and piercing die and requires neither forming nor drawing.

If either forming or drawing or both are required on the stamped part, the chances that the die casting will prove cheaper are increased. They are still further increased if the product, when wholly or partly stamped, has to be made in two or more parts that must be assembled. A single die casting often takes the place of two or more stampings or of assemblies that involve stampings, saving handling and assembly costs, lowering tooling costs and arriving at the final result with fewer operations.

Fig. 2—Were these parts to be made of stampings, several elements would be required, resulting in an assembly operation.

Fig. 3—These parts are die cast with bosses and shafts in one piece. The flat sections could be stamped but other elements would have to be made by other means.

Since over-all costs always depend upon several factors, however, it is unwise to jump to conclusions. It is more logical to weigh each factor before arriving at final decisions but, as experience has shown that the die casting often is more economical or better or both, its possibilities deserve more general consideration than they receive in the average case. The materials from which the parts are to be made is, of course, one of the major considerations.

This becomes more apparent when specific instances are considered. Those described here are all favorable to die casting. Others, in which the balance of advantages favor the stamping are equally numerous. Frequently, a change in specific requirements, say in materials chosen or in the quantities needed, may shift the choice from one production method to the other. As stamping is generally the faster process, it often is cheaper on very long runs where time savings offset the tooling costs.

A steel stamping that merely has to be blanked or only blanked and pierced is likely to cost less than the equivalent die casting unless the stamping involves considerable waste of stock. If there is much waste in stamping, the die casting may cost less.

For a part such as that in Fig. 1, which is a flat strip 11 in. long and 1-3/16 in. wide, with a pierced ear at each end, a die casting was chosen, partly because the blade tapers from 0.046 at one edge to 0.090 in. at the opposite edge. If stock of uniform thickness with formed ears had been permitted, a stamping would have cost less, since there need be very little waste of stock. However, perfectly square sharp edges at the ends, as in the die casting, would not have been feasible. As the die casting met the particular conditions, and die costs were low, the casting gained preference.

Although the flanged portion of the part, Fig. 2, could easily be blanked and pierced, formation of the hub would be costly and the ring surrounding the hub would have to be a separately formed piece attached by some means, such as soldering. As a die casting, the part is produced in one piece, the section varying somewhat, as specified. The net result is a less expensive part, involving practically no waste.

It would be a simple matter to blank the flat portions of the parking meter parts, Fig. 3. But separate parts, made on one or more other machines, would be needed for the pivot shafts and lugs and their cam-like projections and these would require assembly operations. Clearly it is much more economical to die cast the two parts each in one piece, lugs and pins being integral and holes cored. There are no separate elements to make and handle and no assembly operations on either part. Flat portions are only 0.052-in. thick and could be little if any thinner if stamped from sheet.

A bezel having three dial openings, nearly if not quite equivalent to that shown from both sides in Fig. 4, undoubtedly could be produced as a stamping by blanking, piercing, forming and drawing operations but blanking and piercing, drawing and trim dies would be needed and, even then, the product would lack the clean-cut lettering and the fastening lugs provided in the die casting. This zinc alloy casting averages about 0.050-in. thick and involves virtually no waste whereas the stamping would waste considerable stock. If stamped from nonferrous metal, scrap loss would be high and, if stamped from steel,

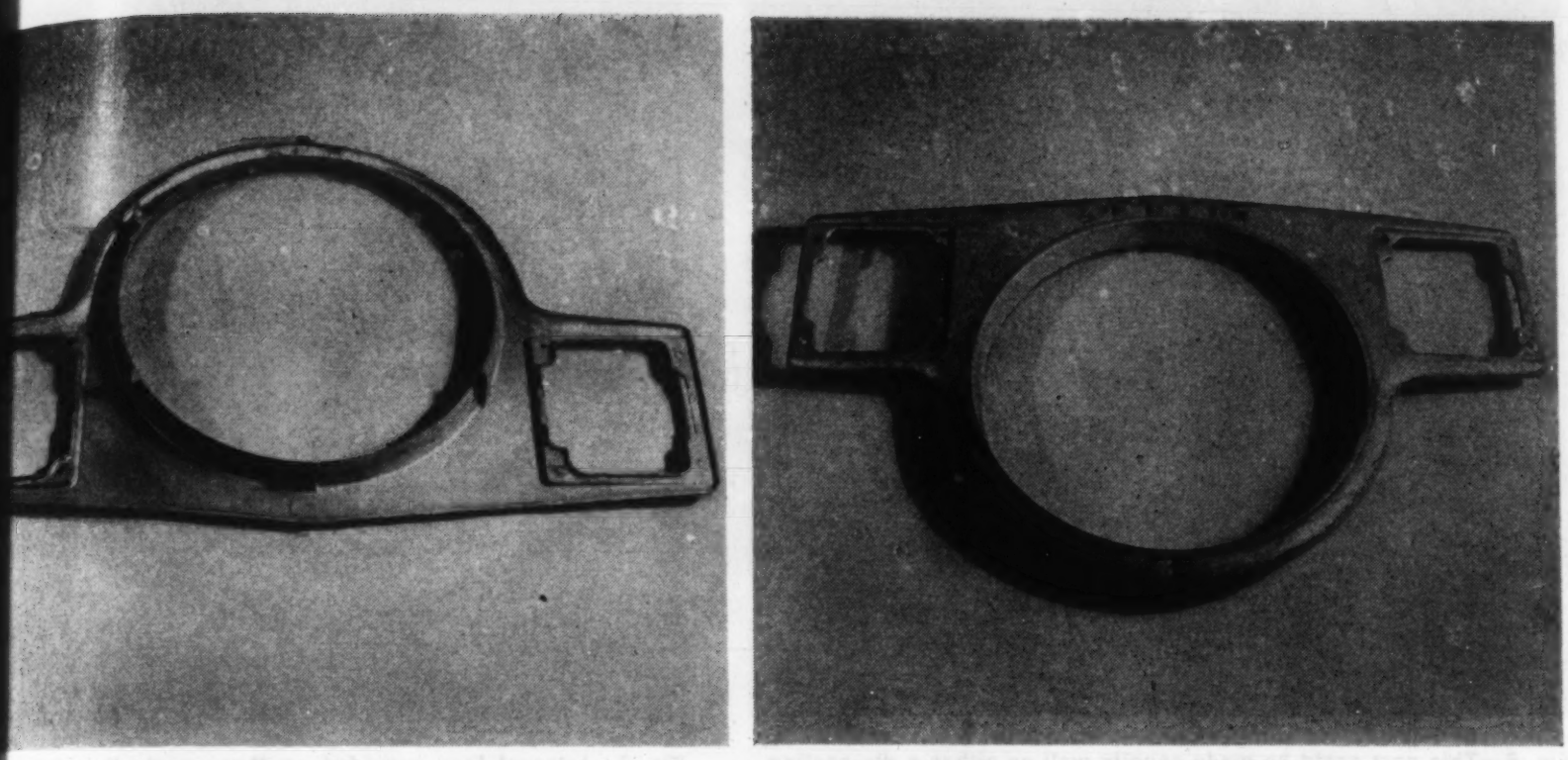


Fig. 4—This radio bezel now a die casting could be stamped with minor changes in design.

although this waste would cost less, it still would be considerable.

The die casting has thin ears around the central opening, these presumably being bent down to fasten a glass in place. Although similar ears could be made on the stamped product, they would add considerably to its cost. With the die casting, the ears add almost nothing to cost.

Except for the integral lug at one end, the gear cover shown in Fig. 5 could be blanked and drawn from sheet stock in a stamping press, using stock about 0.078-in. thick, the same as in the die casting. For a stamping, however, rather expensive blanking and piercing, drawing and trim dies would be needed and considerable scrap in flash would result. A lug, produced separately, would have to be made and assembled in order to duplicate the shape attained in the die casting. Tooling costs certainly would be higher for a stamping, and material costs would be greater unless steel were used. So, again, the die casting was the logical choice and yields the greater economy with advantages on some other scores. If stamped, this part would require trimming after drawing and, as its edges are irregular, this would require extra dies and extra operations costing more than on the die casting.

Substantially the same can be said for the motor ventilating cover, Fig. 6, which is die cast in zinc alloy, with uniform walls 0.065-in. thick. This part could be drawn but an expensive draw die, in addition to those for blanking and trimming, would be needed. The ventilating holes, omitted on some castings, are pierced with a gang punch on the die casting, much as they would be on a stamping. These holes could be cored but, as punches would be needed anyway to remove flash in that case, and as the section is thin, the holes are pierced. Slugs punched out can be remelted, hence do not constitute net waste, as they would on a stamping.

Rings, two of which are shown in Fig. 7, have an L-shape section only 0.050-in. thick and are die cast in large numbers, to use on sealed beam headlamps. Such rings could be drawn from sheet stock except for the lugs required on the front face, these being thicker than other portions. If drawn from sheet stock, however, high loss in scrap blanked from the center and corners would result. Hence the makers, both on these scores and because drawn parts would

Fig. 5—On this piece, the fact that the lug could be formed integrally led to die casting as the production method.

Fig. 6—This part could be made equally well as either a die casting or stamping. Were steel the material used, stamping would be preferred.

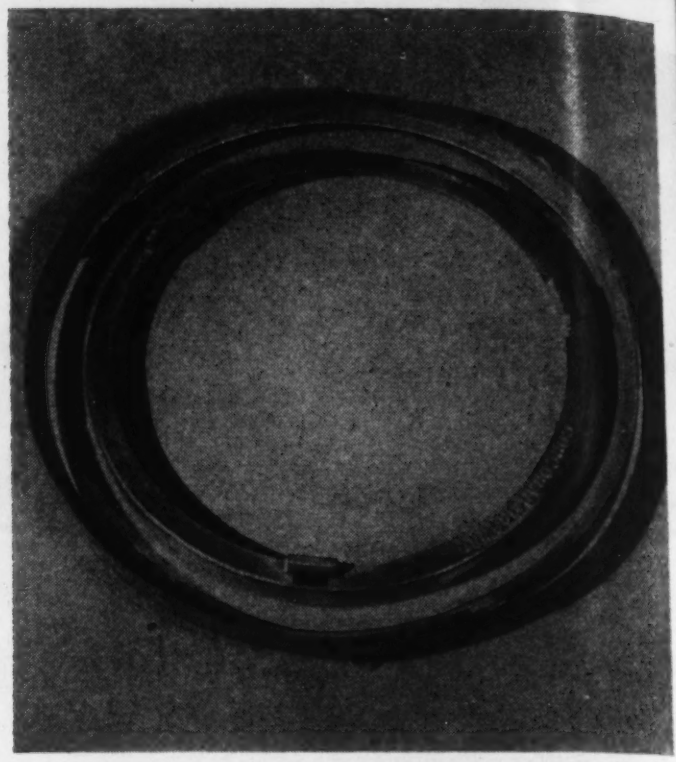


Fig. 7—Integral lugs provided on these parts tipped the scale in favor of die casting.

lack the lugs which are essential, specify die castings, a portion of which is spun over a mating part at assembly.

Many small parts on the order of the bell crank shown in Fig. 8 have been blanked from sheet stock but when, as in this case, bosses, even those that are quite shallow, are required around two holes, the stamping would have to be coined or swaged to raise the bosses. The extra die and operation, plus the fact that there is no waste metal and that holes are precisely cored in the die casting, make the latter the better choice. Total thickness at bosses is 0.130 in. and at other portions is 0.100 in. Edges probably are smoother than in a stamped part and no tumbling is needed.

The other die casting shown in Fig. 8, has a 15/16-in. square flange only 0.035-in. thick but the total thickness at the boss (which has a stepped cored hole) is 0.085 in. and the radial width of the boss is 1.16 in. This part could be stamped but only by coining or swaging to provide the extra thickness in the boss. Moreover, there are short ribs at two opposite diameters of the boss and under each rib on the face of the flange is a slot 0.035-in. square section. These ribs and slots, although possible in a coined stamping, would be expensive and die costs would be high, especially if slots with sharp corners and close dimensions had to be maintained. In any event, the die casting is simpler to produce within required dimensions, and tooling costs are lower.

Small die castings, such as those in Figs. 8 and 9, are easily produced in multiple-cavity dies, if quantities required are large. This yields an added advantage for the die casting, as the rate of making the castings is multiplied by the number of cavities in the die. There is no exact parallel for this in stamping. Although multiple blanking often is done, it is expensive to provide dies for forming, drawing and coining or swaging operations and then, even if and when feasible for parts shaped as in Fig. 8, much higher die costs than for multiple-cavity casting dies are involved. Even quite large die castings often are made in dies having two or more cavities.

Reflectors for flashlights, one of which is shown in Fig. 9, have been made by die casting in lots believed to total several million, using multiple-cavity dies. For the reflector proper, an exceedingly smooth and true parabolic surface is produced and it is easily buffed to a high polish and plated. The die casting includes a tubular socket recess having a three-step cored inner diameter and a two-step outer diameter. On the latter are short ribs parallel to the axis, presumably to prevent the part from turning in a mating assembly. Thickness of the reflector portion is about 0.040 in. and there is a very narrow flange at its outer diameter.

This zinc alloy die casting is made, of course, in one piece and requires no machining, save flash removal. For years it has competed successfully with stamped substitutes, as they either had to be made in two or more pieces and assembled or, if drawn in one piece, would not duplicate the stepped arrangement required in the socket tube and would lack other features of the die casting. A stamping can have a thinner section but might go out of shape when buffed.

Fig. 10 shows a zinc die casting which is a cylindrical bottomless cup 3½ in. in outside dia., 4¼ in

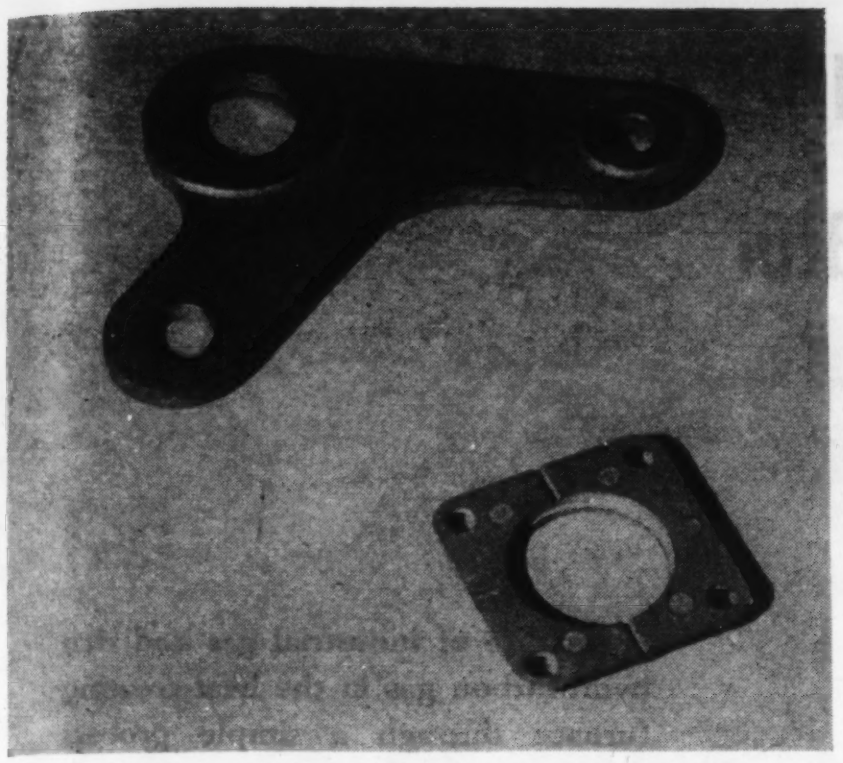


Fig. 8—Stamping could be utilized to produce these parts if the bosses were formed by an additional coining operation.

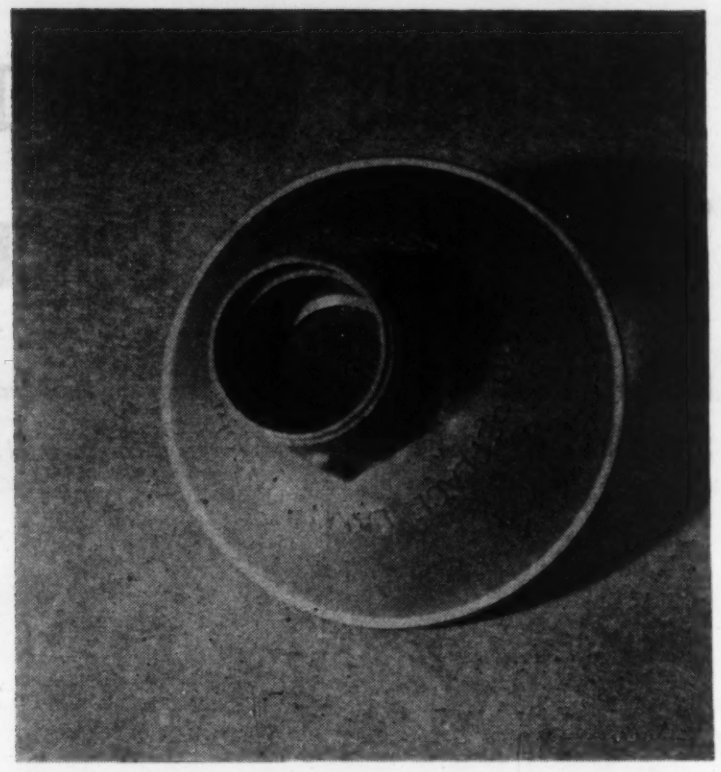


Fig. 9—Flashlight reflector with integrally die cast socket. Equivalent parts are stamped but not to identical shape.

long and having a wall 0.050-in. thick. At one end, this part has a narrow turned-in flange with a beveled internal face. This latter feature more or less dictates a die casting, as a drawn part would require extra operations and perhaps an extra die to produce this tapered flange. A cup of this type could be produced by impact extrusion but then would have a bottom to be sheared out and scrapped.

Cylindrical cups with or without bottoms can be produced with high economy either by drawing or by die casting (and often by impact extrusion, which need not be considered further here). Choice often depends upon the material chosen and the cost of tooling as well as upon such factors as wall thickness, depth of draw and dimensional tolerances specified. The die casting usually has advantages from the standpoint of low tooling cost, minimum scrap loss and ability to provide almost any shape of bottom or of flange either internal or external.

These advantages *may* be offset in a stamping by a higher drawing rate, possible use of a lower cost material, say steel, or some other factors. As no unvarying rule can be given, it is wise to analyze each case on its merits and to choose that yielding the best compromise as to cost and qualities provided.

Most of the parts here shown could also be die cast in zinc or aluminum alloys, which rank second in extent of use. Die castings based on copper, on magnesium, on lead and on tin are also available. None are made in iron or steel, so widely used in stampings.

From the foregoing, it is clear that die castings often compete successfully with stampings and sometimes yield advantages not attainable at equal cost in equivalent stampings. This being the case, it is expedient for the designer at least to study the possibilities of die casting a given part unless he is certain that the stamping will yield required results at a lower cost or accomplish something that no die casting can duplicate.

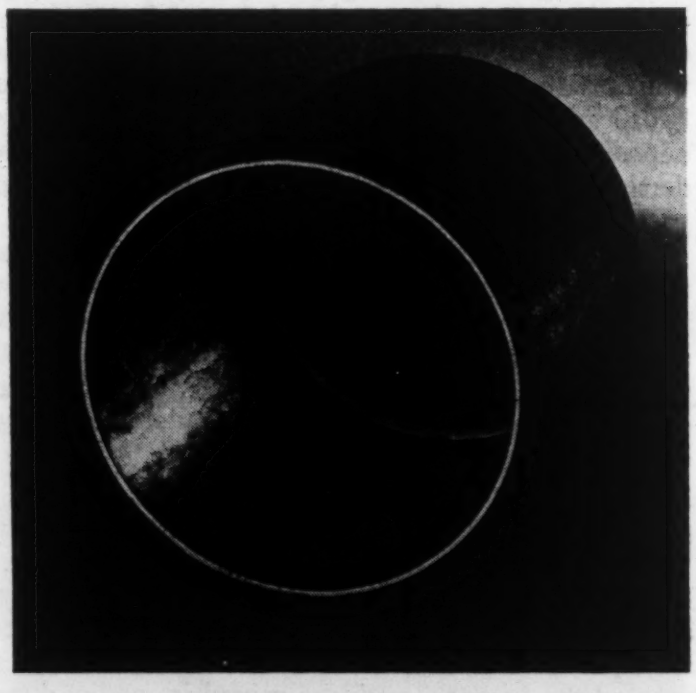


Fig. 10—Die cast tubular part with narrow internally beveled flange at one end. Similar parts are often drawn, but require extra operations for a flanged or tapered section.

Continuous Gas Carburizing of Steel Without a Gas Generator

by **WALTER H. HOLCROFT,** *Vice President and Technical Director*
and **EDWARD C. BAYER,** *Metallurgical Engineer, Holcroft & Company*

A mixture of industrial gas and rich hydrocarbon gas in the heat treating furnace through a simple process makes possible continuous gas carburizing without additional equipment.

GAS CARBURIZING is usually accomplished by subjecting the work to a controlled furnace atmosphere made up of hydrocarbon and diluent gases at a suitable high temperature. Most commonly, the diluent gas is supplied by a gas generator unit which is separate from the furnace. Holcroft engineers have found, however, that in many cases the gas generator can be dispensed with; and a mass-production furnace recently installed at a leading farm implement plant will serve to explain how this is accomplished.

Such an installation offers obvious economies with no sacrifice in either speed or quality of work. Initial investment, maintenance and fuel costs for the generator are eliminated, and floor space is made available for other purposes.

In the gas carburizing process, hydrocarbon gases break down to carbon and hydrogen when exposed to carburizing temperatures. The resulting carbon either unites with the steel or is deposited as soot. If gaseous hydrocarbons are used undiluted, the amount of soot deposited on all exposed surfaces is excessive and is detrimental to the carburizing process; so diluent gases are used to prevent this.

If the hydrocarbons are too highly diluted, however, the result will be a low-carbon and relatively shallow case in a given time. Thus, proper controlled dilution is required to give the desired case characteristics and speed of carburizing. The amount of dilution is determined by the particular requirements of the work at hand.

How Generator is Eliminated

Holcroft engineers concluded several years ago that a separate source of diluent gas would not be necessary provided that the rich hydrocarbon gas, as it entered the furnace, could be mixed immediately with the partially-spent gas in the furnace chamber. This theory has been put into practice by drawing the spent gas from the furnace, mixing the hydrocarbon gas with it, and then introducing the mixture back into the furnace, proportioned to the various inlet pipes as desired.

In addition to the hydrocarbon gas, a sufficient volume of other gas must be added, to make up for any leakage and to provide for adequate flushing of the furnace vestibules so that no air will enter the carburizing chamber. It has been amply proven that most types of industrial gas can be used for this purpose, including manufactured, natural and mixed gases, provided that the carbon dioxide, oxygen and hydrocarbon content of the gas is not too high.

The furnace shown in Figs. 1 and 2 provides a typical example of these principles in operation. These principles have been successfully applied during the past ten years.

In the installation illustrated, the bulk of the diluent gas consists of gas from the carburizing chamber, which is recirculated by a blower as shown in Fig. 1 to give positive motion to the furnace atmosphere. A sufficient volume of manufactured gas is added to the furnace to maintain furnace pressure and provide for flushing; and to this combination of diluent gases is added propane in the quantity required for proper carburization of the work.

This furnace uses 125 cu. ft. per hr. of manufactured gas and 14 cu. ft. per hr. of propane. The nominal analysis of the manufactured gas is as follows:

Carbon dioxide	1.8%
Illuminants	3.0%
Oxygen	0.6%
Carbon monoxide	18.0%
Hydrogen	53.1%
Methane	18.4%
Nitrogen	5.1%

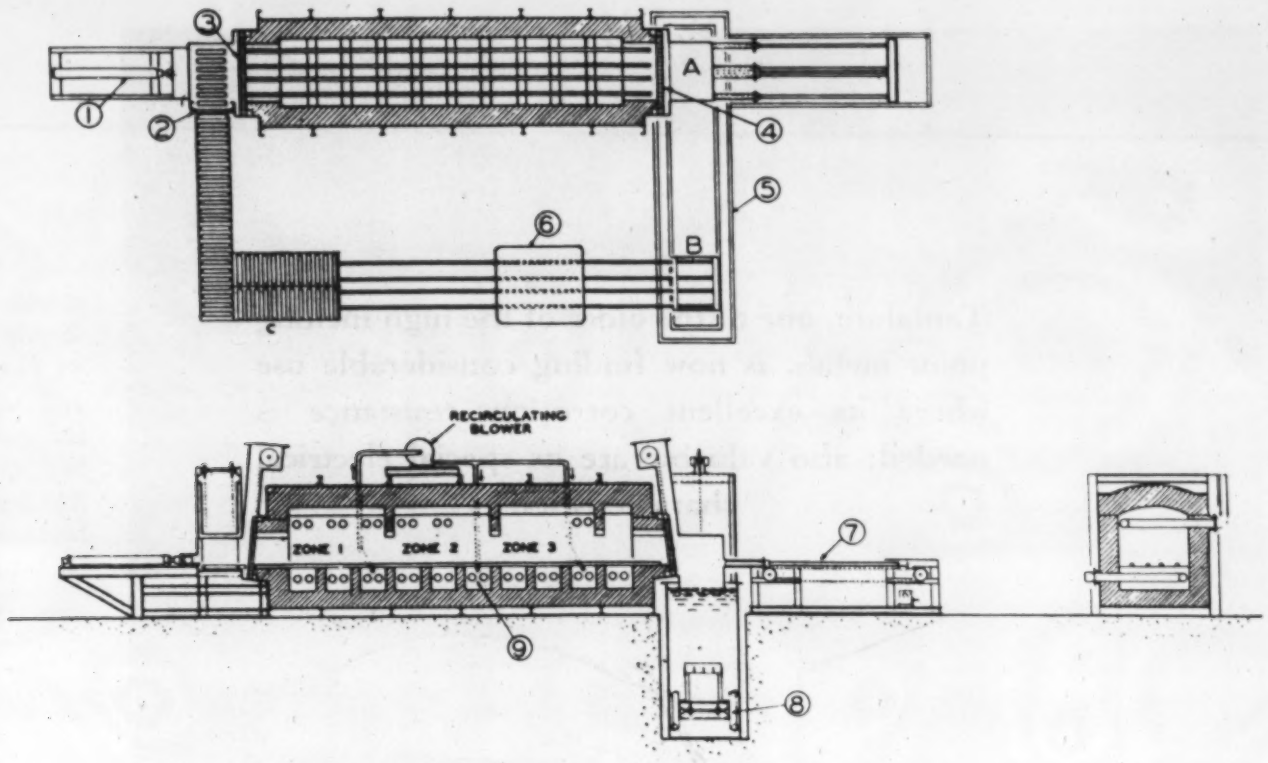


Fig. 1

The high percentage of carbon dioxide in the city gas is decreased to a negligible proportion by the large volume of gas recirculated from the furnace.

At the start of a job, the required composition of the furnace atmosphere is readily computed, and is checked by running through a test load. The atmosphere is maintained thereafter simply by maintaining the required input of gases as determined above, checking daily with an Orsat gas analyzer to see that conditions remain constant. The same procedure is, of course, followed at the start of each new run where the load factor or case requirements are different. A record of furnace operating conditions for each job will enable results to be quickly duplicated at any future date.

This is a two-row pusher-type furnace, heated by gas-fired alloy radiant tubes. The three zones are over and under fired as shown in Fig. 1, and are operated at 1630, 1700 and 1600 F, respectively, the stock being oil quenched from 1560 F to minimize distortion. The burners operate on automatic high-low control to maintain the required temperatures, and are of closed-head design, with both gas and air positively metered to give maximum combustion efficiency on both the high and low settings.

Automatic Operation

Except for loading the stock into the furnace vestibule, operation is fully automatic. Referring to Fig. 1, the operator opens the outer charge door (2) by push-button control, pushes two loaded trays into the vestibule and closes the door. At the proper time, the inner charge door (3) opens and the hydraulic pusher arm (1) pushes the trays into the furnace proper on rolled alloy skid rails, thus advancing all the trays in the furnace.

By this time, the inner discharge door (4) has opened and hydraulic pullout arms (7) have pulled two trays of carburized work from the furnace onto the quench tank elevator (8), which is then at position A (in the discharge vestibule). The elevator carries the work down into the quench tank (5), transfers to position B and comes up after the quenching operation. The trays are then pulled into the wash (6) automatically, and are finally conveyed to unloading position C.

This furnace normally operates on an 8.7-hr. cycle with a production of 320 lb. per hr. The push rate is readily varied, however, to permit processing a variety of work to different case depth requirements.

Holds Charge Over Week-End

In this case, as in others, the furnace is not shut down for week-ends or holidays. Instead, the temperature is reduced and the propane input shut off. The load remains in the furnace without damage until the next working day, at which time normal operation is quickly resumed simply by raising the temperature to working level and resuming the addition of propane to the carburizing chamber.

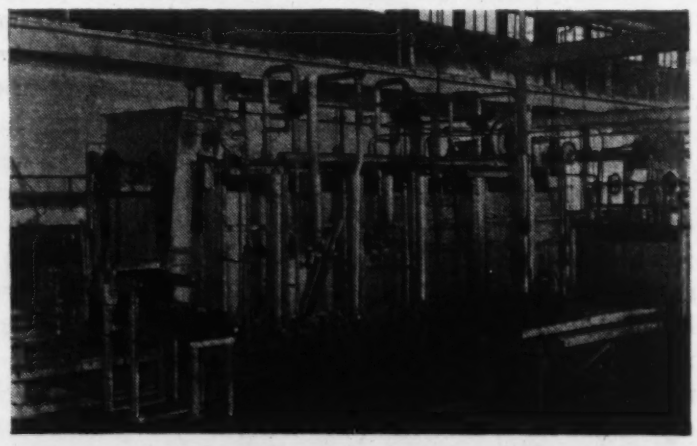


Fig. 2—Gas carburizing is done in this furnace without the use of an external gas generator.

Tantalum, one of the older of the high melting point metals, is now finding considerable use where its excellent corrosion resistance is needed; also valuable are its special electrical characteristics.

Tantalum as an Engineering Material

by **KENNETH ROSE,** *Engineering Editor,* MATERIALS & METHODS

WITH PRESENT INTEREST IN METALS of high melting point, a metal melting at 5400 F is sure to be noticed. When to this is added a price that puts it in the commercial range, good hardness, and other interesting properties, tantalum would seem to be just what is needed by the metallurgist seeking a material for high temperature service. Only one obstacle appears, but that one is sufficient to preclude its use for most of the purposes for which high temperature metals are now being studied so intensively. Tantalum oxidizes readily at elevated temperatures, and so can be used effectively over its high-temperature range only in a vacuum.

Despite the fact that this readiness to take up oxygen at elevated temperatures makes tantalum unsuitable for such high-temperature applications as the gas turbine, it offers a combination of properties highly desirable in many fields of industry. One of these takes advantage of the ready oxidation of the metal, and uses it as a continuous "getter" in electronic tubes. Others find its extremely high resistance to chemical attack valuable. Certain electrical properties are much used in rectifiers and condensers.

The properties of tantalum that dictate most of its commercial applications, and those applications broadly grouped, might be given as follows:

(1) *High resistance to chemical attack.* Tantalum resists attack by most acids except hydrofluoric and fuming sulfuric acids. Solutions of strong alkalies attack the metal also. It has about the same chemical resistance characteristics as glass. For the chemical industry, therefore, its use is generally confined to such apparatus as must withstand chemical attack and permit rapid heat transfer, as in heat exchangers, condensers, or absorption towers. Where chemical resistance only is required, a cheaper material, such as glass, would be just as satisfactory. Strength associated with corrosion resistance is another condition that sometimes swings the choice to tantalum, as in diaphragms for proportioning apparatus.

It is interesting to note in passing that surgical uses are taking increasing quantities of the metal. It has been found that the body not only does not corrode tantalum, but living tissues seem to accept it. Sutures, skull plates, fixation plates, gauze and tiny sleeves for nerve repair are present uses.

(2) *High temperature service in vacuum.* Tanta-

Annealed tantalum is malleable and ductile and can be stamped, formed and deep drawn by conventional techniques. The metal takes a permanent set in stamping and does not spring back from the dies. (All photos: Courtesy Fansteel Metallurgical Corp.)

lum serves excellently as anode or grid, or both, in electronic tubes. Its supplementary action as a continuous "getter," ridding the tube of the last traces of gas, has already been noted. As some metals do not wet tantalum, it may be used for a crucible to melt copper, evaporate mercury, or similarly treat these non-wetting metals, provided the operation is carried out in a vacuum.

(3) *Special electrical properties.* In an electrolyte tantalum forms an oxide film that will conduct a current only when serving as a cathode. This property forms the basis for its use as a wet rectifier, and as a lightning arrester. A valuable feature of this film is that it is reformed immediately if broken, as by a lightning flash.

Porous metal compacts of tantalum find use as a wet condenser also, and fit into various electrical circuits where high capacity is required.

(4) *Formation of a carbide that enters into industrial carbide compositions.* Tantalum carbide forms a part of several types of cemented carbides, used for metal cutting tools, dies and wear-resisting parts.

(5) *Formation of salts with valuable properties.* Tantalum oxide is one of the substances in a special optical glass; other tantalum compounds are important catalysts in the chemical industry.

Industrially, tantalum has had a history as interesting as its present uses. In 1903, a century after its discovery, it was used to make the first metallic filament for the electric lamp, which had been using a carbon filament as its incandescent element. Shortly thereafter ductile tungsten was produced, and became the basis for the filament now used.

The development of tantalum in its early stages was retarded by the difficulty of producing the metal. After separating the metallic salt by wet chemical means, and reducing to metal with sodium, an ingot about the size of a silver dollar was melted down in partial vacuum on a water-cooled table. It was impossible to anneal the resulting metal because of its contamination with oxide. The lamp filament was produced as a metallic powder, and drawn through a die. Some of the metal was used in Germany to make dental or surgical instruments, but its large-scale applications in industry had to await the discovery of better methods of reduction to metallic state.

The present method involves separation of tantalic

Tantalum chemical plant equipment is made by sheet metal techniques including forming and welding. Joining by seam welding is performed under water to prevent oxidation.

acid by wet chemical methods, its separation from columbium by the lower solubility of the double fluoride of tantalum and potassium, electrolysis of the dry double salt, and compacting of the resulting tantalum powder by powder metallurgy methods. Because these processes are intricate and costly, the metal is rather expensive. It costs about $65 per lb. in sheet form. As produced under the present process, the metal is quite ductile and can be worked considerably without excessive work-hardening.

Physical Properties

The melting point of tantalum is one of the highest among the metals—5423 F. It is a heavy, bluish-gray metal, and resistant to the action of most chemicals, as has been indicated. It absorbs gases readily when hot, and will take up about 740 volumes of hydrogen if cooled from red heat in hydrogen at atmospheric pressure. The carbide is exceedingly hard, and this forms the basis for another group of uses for the material.

The thermal coefficient of expansion is very small, being only 3.6 x 10^{-6} in. per in. per deg. F. The crystal lattice is a body centered cube. Tensile strengths are of the same order as those of steel, with about 50,000 psi. in the annealed condition, and 110,000 psi. when work hardened as average figures. Young's modulus of elasticity is also quite close to that for steel, with 27,000,000 psi. a generally accepted value.

Specific gravity is 16.6, putting it in the range of the noble metals in this respect. Thermal conductivity is good.

Physical properties summarized are as follows:

Specific gravity	16.6
Density, 68 F	0.600 lb. per cu. in.
Melting point	5423 F
Linear coeff. of expansion	3.6 x 10^{-6} per deg. F
Thermal conductivity (20 C)	0.130 cal. per sq. cm. per cm. per deg. C per sec.
Electrical conductivity, copper equivalent	13.9%
Magnetic susceptibility	0.93 x 10^{-6} cgs.
Young's modulus of elasticity	27,000,000 psi.

Form	Thickness of Section, In.	Tensile Str., Psi.	Elongation, % in 2 In.	Rockwell Hardness
Sheet-annealed	0.010	50,000	40	60 (E scale)
Sheet worked	0.010	110,000	1	95 (E scale)
Wire-annea'ed	0.002 (dia.)	100,000	11	——
Wire worked	0.002 (dia.)	180,000	1.5	——
Plate-worked	0.010	145,000	18	103 (B scale)

Commercial tantalum, as produced for the chemical equipment industry, is 99.9+% pure, with iron and carbon, the principal impurities, held to a few hundredths of 1%. In resistance to chemical attack it has almost exactly the same properties as glass. Strong alkalies, hydrofluoric acid, fuming sulfuric acid, and nascent hydrogen have an embrittling effect upon tantalum. Fluorides in solution also attack it. A mixture of nitric and hydrofluoric acids dissolves it rapidly, and such a mixture is used as a metallographic etchant.

Fabricating Characteristics

Tantalum can be cold formed to a considerable degree without annealing. It seems to work harden slightly soon after cold working begins, but then increases in hardness slowly. The sheet stock can be deep drawn without difficulty, but when annealing becomes necessary a complication arises. Annealing must be done in a high vacuum, and, as the size of a furnace of this type is usually small, it is always advisable to plan the drawing operation with the furnace limitations in mind. Even when annealing sheet stock preparatory to drawing, the size of the furnace is a factor to be considered. Large sheets, or sheets of unusual dimensions must usually be coiled, and when uncoiled will not be straight nor flat.

Fortunately, the ductility of the metal is sufficient to permit most drawing operations without an intermediate anneal. Thoroughly annealed stock for deep drawing should be specified when securing metal for such operation.

Hot working is not recommended for fabricating tantalum. The metal starts to oxidize at about 500 F, and at about 900 F the rate of oxygen absorption becomes rapid. Formation of the oxide, and absorption of nitrogen and hydrogen, makes the metal brittle.

Resistance welding can be used to join tantalum, if techniques are modified slightly. Seam welding will produce a tight joint, and the metal can be protected from oxidation by making the weld under water. Spot welding is accomplished by using very short cycles, less than one cycle per spot, and high current densities to get fusion without oxidation.

Arc welding can be used also, but is not usually regarded as a commercial process. Using a carbon electrode submerged in carbon tetrachloride is a method that has given satisfactory results at Western Electric Co., which company holds patents upon it. Arc welding under a protective atmosphere of helium has also been used successfully, though it is necessary that the helium be carefully purified. These methods have been used to weld the flanges of sheets, and a true fusion weld has been produced.

In addition to weldability to itself, tantalum is weldable to those metals with which it forms solid solution alloys. For most engineering purposes, nickel is the favored metal. Tantalum and nickel are readily joined, especially when the alloy formed contains less than 40% tantalum. With higher percentages of tantalum, compounds are formed and the weld may be somewhat brittle. Alloys are formed with molybdenum and tungsten in all proportions, and with aluminum and magnesium, and tungsten to a more limited extent. Cobalt forms alloys readily, iron less so, and gold to the extent of about 1% of tantalum. Platinum welds readily to tantalum, and a platinum wafer may be used as a brazing material in welding to very high-temperature materials such as tungsten.

Tantalum metal powder is compacted in this 3,000-ton hydraulic press to form bars and ingots suitable for further processing.

Tantalum is practically unmachinable by ordinary methods. It galls and tears badly under the cutting tool. However, if high-speed steel tools are used for cutting, and carbon tetrachloride as a lubricant, it can be machined about as readily as copper or stainless steel. As a practical measure the carbon tetrachloride is mixed with an equal volume of machine oil to reduce its rate of evaporation.

Grinding is not recommended as a means of forming tantalum. Particles of the abrasive tend to become impregnated into the metal, and the finish suffers accordingly. If grinding is necessary, an ordinary emery wheel with a hard binder is the best type to use. Casting is also impractical as a commercial operation, though it has been done experimentally in several plants.

If tantalum is intended for use at elevated temperature in a vacuum, as in an electronic tube, it should not be ground, blasted, nor otherwise worked with the ordinary abrasives, as imbedded particles of these tend to decompose at high heat in contact with the metal. The surface can be blasted with steel grit if necessary, and afterwards treated with hot hydrochloric acid to dissolve any imbedded steel.

Tantalum can be spun without difficulty. A forming tool of brass or bronze is preferred for the spinning operation.

Brazing can be accomplished with silver solder,

provided the surfaces to be joined are prepared by "tinning" with the silver solder while submerged in molten potassium tantalum fluoride at approximately 1470 F. Tantalum is not wetted by soft solders. This fact is utilized in soldering operations upon other materials, for which a fixture of tantalum can be used to hold the work without danger of being itself bonded by the solder.

There is no commercial process for electroplating tantalum onto a base metal. Other metals may be deposited onto tantalum, but they do not bond to it. Here again use is made of the peculiarity of tantalum by forming clamps or supports of the resistant metal for work being treated anodically. The rectifying effect of the oxide film prevents any of the current from passing through the supports, and so all of it must go through the work. This property is advantageous in electropolishing, electropickling, and anodizing. It cannot be used where the tantalum support would become the cathode, as hydrogen liberated at the surface of the tantalum would cause embrittlement.

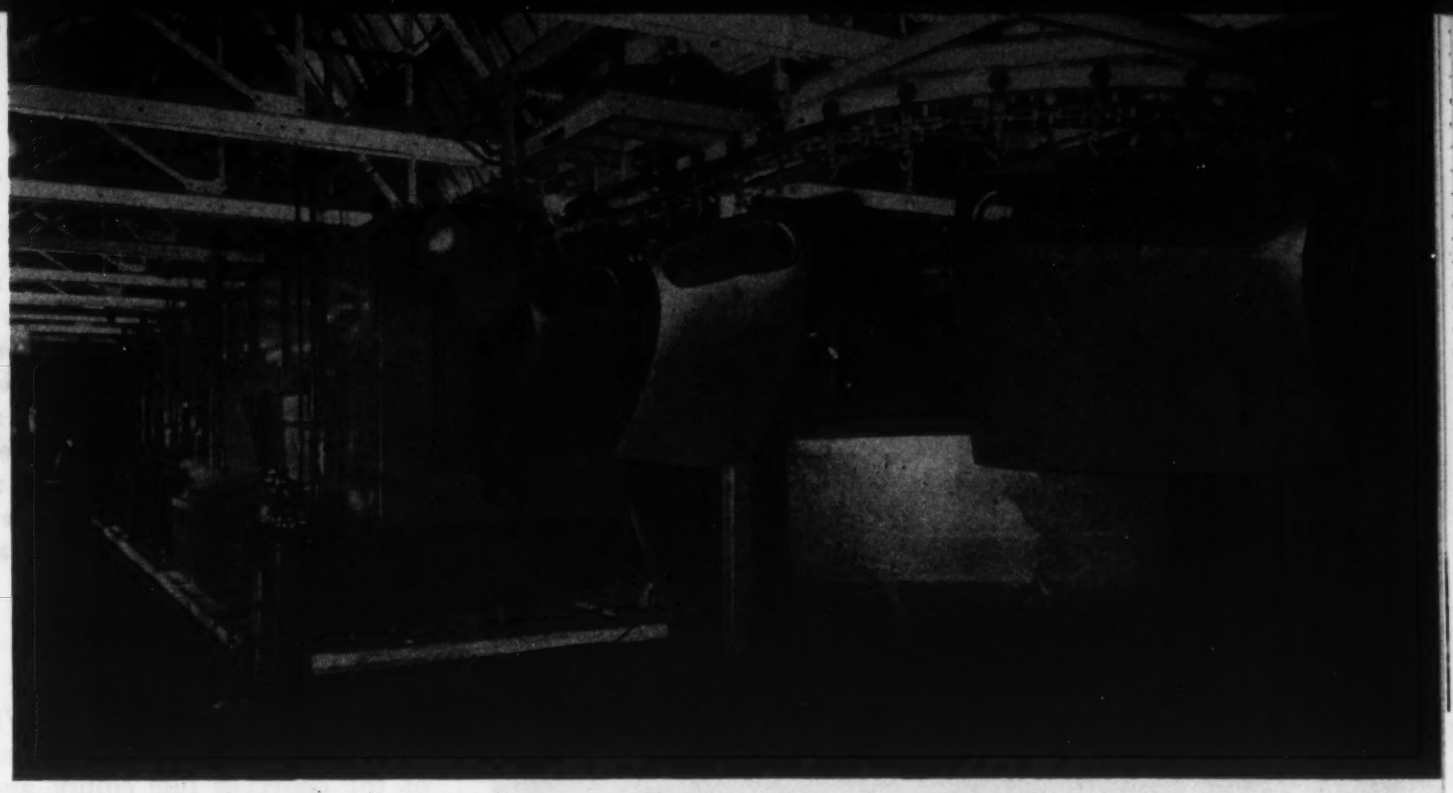
While some of the usual fabricating possibilities for metals are not adaptable to tantalum, the properties of the metal introduce several unusual ones. The self-welding feature is an example. If one tube be forced over another slightly smaller so that they lap for about 1 in., a secure joint will result from the galling of the metal, without additional fastening. Likewise, the nonbonding property of tantalum is developed into a forming method by spraying a mold with the metal, usually with addition of a binder, destroying both mold and binder by heating in a vacuum, then sintering the "cast" of tantalum at high temperature in the vacuum.

The methods of powder metallurgy are of great importance in the technology of tantalum, as they are with most of the high-melting metals. The final steps in the process of winning the metal from its ore consist of repeated compacting and sintering. Operations with tantalum carbide are likewise in the field of powder metallurgy, as are forming procedures with the metal itself.

Tantalum has won a secure place for itself in the fields for which it is adapted. Absorbing towers for the production of hydrochloric acid and nitric acid have demonstrated their efficiency, and at present about 50% of the former acid made in this country is made in tantalum towers. The combination of high melting point and gas absorbing power assures its use in vacuum tubes for electronic applications, especially radio transmission. Its wet rectifying action takes it into the telephone switchboard circuits as a filter, as a charger in battery-operated railway signal equipment, as a lightning arrester, and in many others. Both cemented carbide cutting tools and cast alloys of high hardness use tantalum, and it increases the life of forming dies, wire drawing dies, formed tools, lathe centers, tube dies, and wear-resisting parts using these compositions. Special springs for high-temperature, high-vacuum use are made of a tantalum-tungsten alloy.

For the present, cladding of base metals with tantalum is a field being studied, and while the difficulties of unlike thermal expansions have not yet been solved, it holds out possibilities of a new series of composite materials. Casting of tantalum or of tantalum alloys, perhaps from crucibles of fused thorium oxide, is another future possibility.

Compacted metal bars are sintered under high vacuum in special furnaces. Electric current causes the powder particles to fuse without actually melting. After sintering, all further working of tantalum is done cold.



Aluminum panels entering the spray-bonderizing unit at GMC Truck-Coach Division.

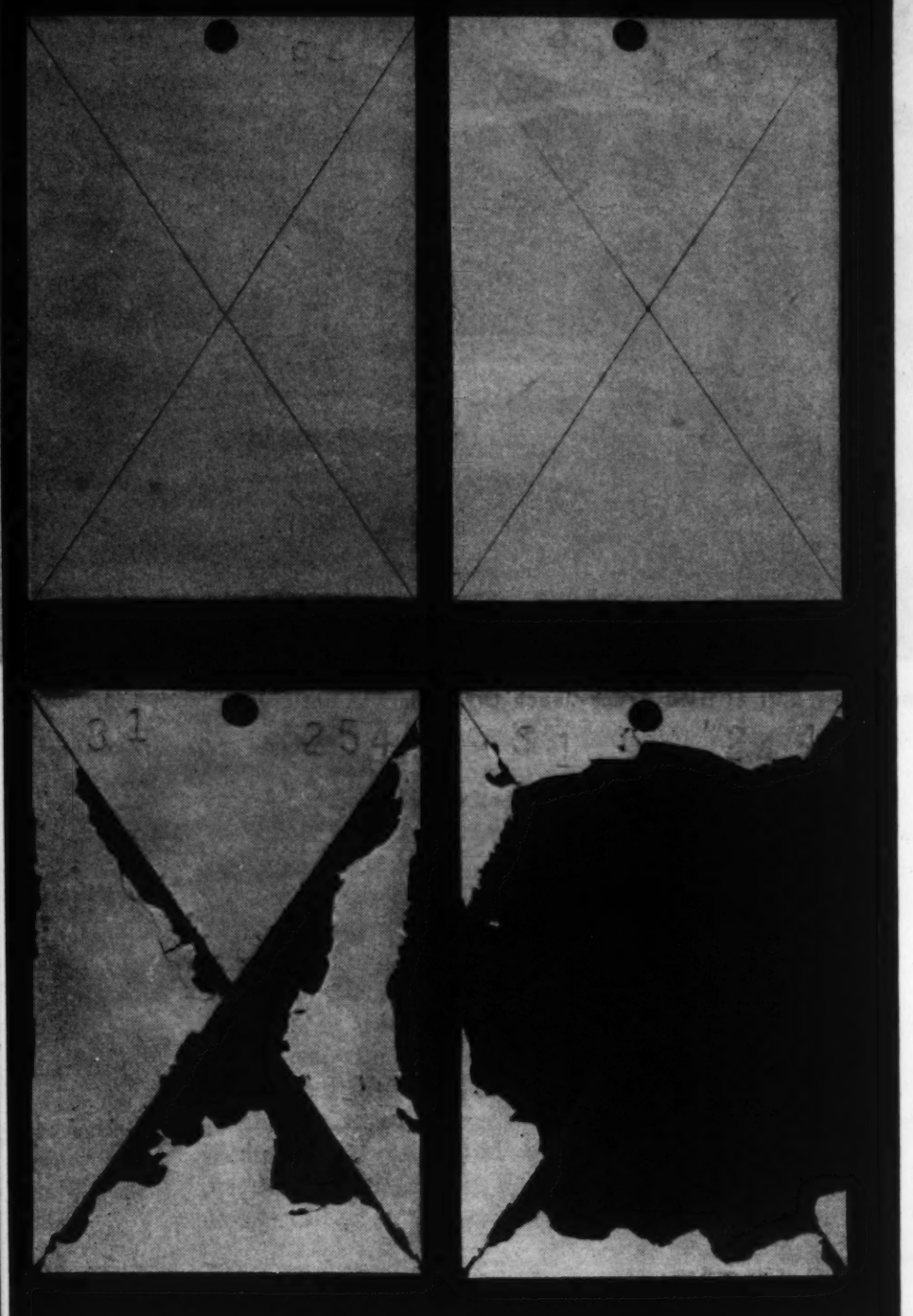
New Bonderizing Process for Aluminum and Steel

by **HAROLD A. KNIGHT,** *News Editor,* MATERIALS & METHODS

RESULTS OBTAINED OVER A PERIOD of more than a year of tests and trials on a production basis indicate that a new Bonderizing process developed by Parker Rust Proof Co., Detroit, may be the answer to several finishing problems for steel, galvanized steel, and aluminum. The process makes possible the continuous treatment, in one standard solution, of all of these materials, and provides an excellent base for paint.

Problems encountered in using sheet steel and sheet aluminum on the same production line are lessened by a phosphate treatment which works equally well on both materials with identical treatments.

Installations have already been made at many plants throughout the country. One of the first and largest is located in the plant of the Truck & Coach Div., General Motors Corp., Pontiac, Mich. Other large installations have been made in the General Electric Co.'s electrical appliances plant at Bridgeport, Conn.; Consolidated-Vultee Corp.'s Nashville plant, and Easy Washing Machine Co.'s plant at Syracuse, N. Y.



Here aluminum alloys are shown after nine months outdoor exposure to determine adherence of coatings. Those at left are 52S-HH while the other two are 24ST aluminum alloy. The top row samples were phosphatized while those below were only solvent cleaned. All samples were covered with one coat of an urea formaldehyde white baking enamel.

The problem at the GMC Truck & Coach plant was typical of that at many others. Both steel and aluminum sheets were used in building the shells of the large busses and trucks turned out at this plant. It had long ago been found necessary to use a preparative treatment of the metal to insure proper adhesion of the primer and top coats of paint on the body of the vehicle, and a Bonderizing process was used for the steel sheets. Anodizing the aluminum sheets was satisfactory, but, being a batch process, it did not fit into a continuous production line smoothly. A caustic etch was used for several years, but it was not entirely satisfactory because of the difficulty of washing the sheets free of caustic soda. The company's process engineers wished to find an effective treatment for the aluminum sheets that could be accomplished on a continuously moving line.

Abandoning the anodizing treatment in favor of the caustic etch made possible a continuous treatment of the aluminum sheets, but made necessary the establishment of two separate treatments within one conveyor system. The Bonderizing of steel was done by automatically spraying the sheets with the Bonderizing solution as they passed through a tunnel, the usual spray cleaning preceding the treatment, and a rinse and drying following. When aluminum sheets were to be treated, it was necessary to let about 40 ft. of the conveyor line empty, and in that travel time to change over to the solutions for the caustic etch. These consisted of: (1) a mild alkali preclean; (2) spraying with the etching solution, consisting of sodium hydroxide, sodium carbonate, and trisodium phosphate; (3) a water rinse; (4) a weak acid rinse; (5) a second water rinse. The sheets were then dried in an oven as with the steel.

After tests had shown the new Bonderizing solution to be satisfactory, it was put into the system for use with both aluminum and steel. The sheets now go into the conveyor, an overhead chain system with the sheets carried by wire hooks, and receive the entire Bonderizing treatment together. This consists of:

(1) An emulsion cleaner spray.
(2) Two successive water rinses.
(3) Spraying with the Bonderite solution.
(4) A water rinse.
(5) An acid rinse, containing a small amount of phosphoric and chromic acids.

The sheets are in each of the above sprays for about 1 min. Drying in an oven at 250 F for about 1½ min. follows, and the sheets then pass through a paint spraying booth in which the zinc chromate primer is sprayed onto them by hand-operated spray guns.

The Bonderizing treatment produces the usual gray crystalline phosphate coating upon steel. The coating on aluminum is of a similar nature but is lighter in color and at times has a transparent appearance. Although thin, the film is reasonably resistant to abrasion.

In motor busses the sheets of aluminum alloy or steel forming the shell must be resistant not only to outdoor weather conditions, but to the continuing dampness and high humidity resulting from condensation of moisture between the skins of the shell. Zinc chromate primer used over untreated metal adheres poorly under such conditions. With the caustic treatment there was a tendency for traces of caustic to remain in the microscopic crevices formed by etching, and to cause subsequent blistering of the paint. This has been eliminated by the new Bonderizing treatment.

Tests were made by GMC Truck & Coach Div. before adopting the Bonderizing process for alumi-

num, and included outdoor exposure of panels, salt spray tests, water spray tests, conical mandrel tests, and outdoor exposure of panels on the west coast. Results showed the treatment to be satisfactory as a corrosion inhibitor.

The chemistry of the new Bonderizing process does not differ radically from that of the standard method for treating steel. For the usual method of coating, a solution of the zinc dihydrogen phosphate with free phosphoric acid is made up, and permitted to hydrolyze to normal zinc phosphate and free phosphoric acid. In contact with the steel, some of the free phosphoric acid is consumed by attack upon the metal, forming ferrous phosphate and reducing the acidity of the solution. Some of the ferrous phosphate forms a coating at the surface of the work, the remainder being quickly oxidized to ferric phosphate and thrown down as a sludge. The lowered acidity causes some zinc phosphate to be precipitated at the surface of the metal, along with some ferrous phosphate formed by the reaction of the steel and the free phosphoric acid. Hydrogen liberated in the reaction of the steel and phosphoric acid tends to blanket the surface of the work, slowing the formation of the film, and to eliminate this an oxidizing agent is included in the solution. This is usually a nitrate, nitrite, or chlorate. The oxidizing agent also helps to convert the ferrous phosphate to ferric phosphate, and so to remove it as sludge.

For the new solution, the formulation of the bath is changed slightly, and an accelerator is added to get a rapid etch on aluminum. This accelerator is a fluorine-bearing compound, taking advantage of the readiness with which fluorine salts remove the protective oxide film over the surface of the aluminum alloys.

The single bath prepared from the new phosphating formulation, sold by the Parker Rust Proof Co. as Bonderite 170, is effective with steel, aluminum or zinc, and so may be used for surface preparation of galvanized sheet. The advantages of the newer and more versatile bath are obvious from a production standpoint, as only one Bonderizing line need be set up for the entire production of most plants.

Although the new Bonderizing process has been in operation on a commercial scale for only about two years, it is already being used in about seventy plants throughout the country. It may be used as an immersion process as well as by spray application, and so can be made to fit into continuous production finishing treatments of most manufacturing plants having mixed materials going through a preparative process.

Some of the items now being treated by the method are washing machine parts, commercial refrigerators, typewriter parts, food mixers, marine furniture, calculating machines, low temperature cabinets, road signs, juke boxes, vending machines, venetian blinds, scales, air conditioning parts, fluorescent light fixtures, and switch boxes.

Comparison of Bonderite 170 Coatings with Untreated Metal in Salt Spray and Soak Tests

Stock	Paint System	Salt Spray			Soak Test		
			Maximum Creepage			Bonderite	
		Time—Hr.	Bonderite 170	Untreated	Time—Hr.	170	Untreated
2S-½H	A	1092	0	2	741	0	Fail (574 Hr.)
52S-½H	A	1092	0	4	741	0	Fail (72 Hr.)
24ST	A	1092	2	9	741	0	Fail (24 Hr.)
Steel	A	744	0	Fail (168 Hr.)	504	2	3
R301-0	A	744	2	11	504	1	Fail
Electro Zinc Plate	A	201	1	9	339	2	Fail
Galvanized	A	201	0	9	339	3	Fail
2S-½H	B	1092	1	2	741	0	Fail (574 Hr.)
52S-½H	B	1092	0	4	741	0	Fail (72 Hr.)
24ST	B	1092	3	Fail (24 Hr.)	741	0	Fail (24 Hr.)
Steel	B	1015	Fail (839 Hr.)	Fail (204 Hr.)	228	0	Fail (144 Hr.)
R301-0	B	1015	2	Fail (40 Hr.)	228	0	Fail (71 Hr.)
2S-½H	C	1092	0	1	741	0	Fail (574 Hr.)
52S-½H	C	1092	0	2	741	0	Fail (72 Hr.)
24ST	C	1092	0	Fail (72 Hr.)	741	0	Fail (24 Hr.)
2S-½H	D	1092	3	4	—	—	—
52S-½H	D	1092	0	Fail (334 Hr.)	—	—	—
24ST	D	1092	3	Fail (72 Hr.)	—	—	—

Salt Spray—maximum creepage in 1/16-in. units. Soak Test—0—good to 5—failure.

Description of Paint Systems

Paint System	Composition	Baking Schedule	
		Min.	F
A. Refrigerator: Prime Coat	Oil modified alkyd	30	350
Finish Coat	Alkyd + urea-formaldehyde	60	260
B. Interior cabinet	1 coat urea-formaldehyde	15	325
C. Sign: Prime coat	Oil modified alkyd	30	350
Finish coat	Yellow alkyd exterior	30	250
D. Sheet metal	1 coat urea-formaldehyde + modified alkyd	60	260

Fig. 1—Interior view, looking down into new Dilts Hydrapulper during erection at National Paper Corp., Ransom, Pa. All-welded design, using carefully chosen special materials, makes this Hydrapulper one of the most modern units in its field.

Welding and Flame Cutting Applied to Stainless and Clad Steels

by **S. F. DANES,** *Technical Sales Div., Air Reduction Co.*

New materials, when fabricated by the latest cutting and joining methods, combine to result in a product which is ideal for its intended purpose and operating conditions.

SKILLFUL DESIGN TECHNIQUES, more generally thought of in connection with the types of machines which are produced in quantity, are often of even greater importance to the custom-made, individual unit. Such a case is the new Dilts Hydrapulper (Fig. 1.), recently installed in the plant of the National Paper Corp. at Ransom, Pa. The fundamental design of the Hydrapulper, originated by the Dilts Machine Works of Fulton, N. Y., (Div. of the Black-Clawson Co., Hamilton, Ohio) is not new. About 350 of these, ranging in size from

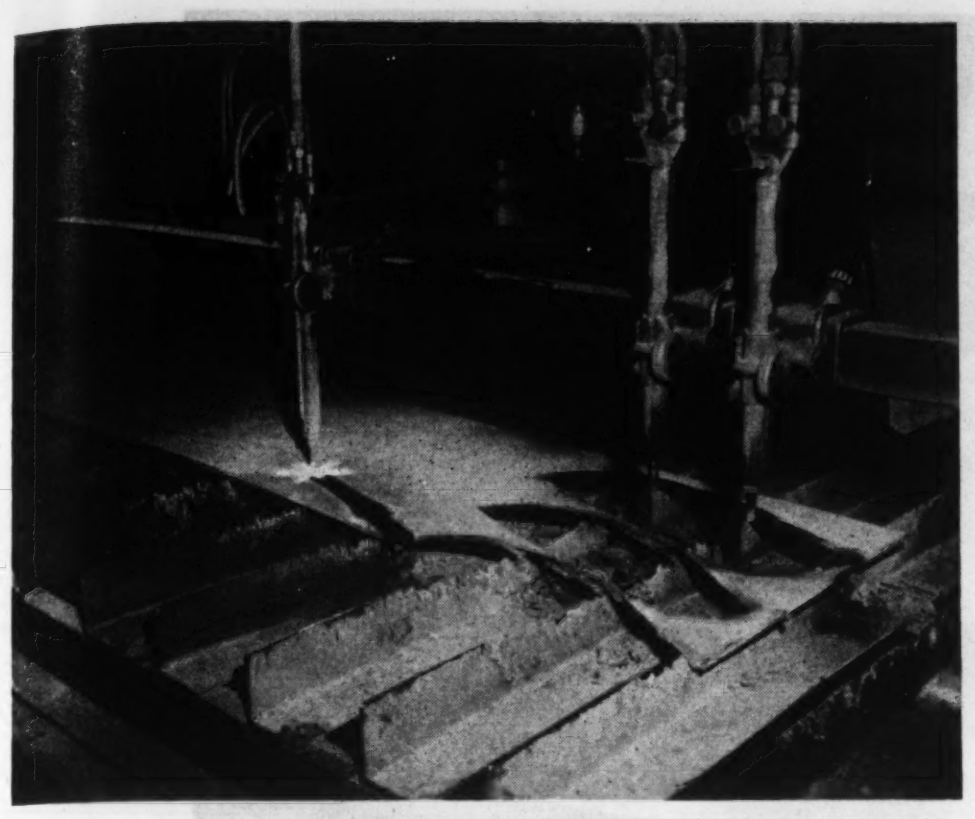


Fig. 2—Flux-injection, a new method, made possible the use of flame cutting for the stainless and nickel-clad components of the machine, with appreciable resulting savings and simplification. The process uses all conventional flame cutting equipment except for the flux feeder unit (background), which dispenses a controlled amount of pulverized nonmetallic flux directly to the cutting oxygen stream which injects it into the cut.

Fig. 3—Quality comparable to mild steel cutting is apparent in these type 347 stainless vanes for the Hydrapulper, flux-injection cut on a standard Oxygraph. Scrap loss was kept to a minimum.

laboratory models only 3 ft. in dia. to 20-ft. units capable of defibering 200 tons of stock daily, are already in operation in the paper industry.

The National Paper Corp. installation, however, called for redesign to capitalize on new materials and on new techniques for processing and fabricating them, to simplify erection, and to provide more trouble-free operation. The result is a modern machine of simplified construction, all-welded, and adapted in every way to the special requirements of its work. By judicious selection of materials and by capitalization on the latest and best available methods of fabrication, a maximum degree of economy was achieved in construction of the machine, with simultaneous improvement in quality.

The unit, 12 ft. in dia. and nearly 8 ft. high, is fundamentally simple—a squat cylindrical tub, with a central rotor in the bottom. This rotor, operating at 195 rpm., reduces the "furnish" of reclaimed paper and virgin pulps to slush form in a matter of seconds, after which sizing and coloring materials are added and blended.

The service conditions under which the Hydrapulper operates are severe. The basic "furnish" is abrasive and the chemical admixtures are often highly corrosive. The size and operating speed of the machine present a constant threat from vibration. Structurally, maximum overall rigidity is an important advantage. Parts, such as screws and bolts, which might loosen under vibration, must be kept to a minimum. The tub must be water-tight, and it is desirable to keep field erection to a minimum, with maintenance problems on the finished unit eliminated as nearly as possible.

All of these conditions were met successfully by the use of special materials for wear and corrosion resistance, and a plan of fabrication, carried out almost entirely in the shop, based upon flame-cutting and welding—which methods develop appreciable auxiliary savings in costs over former laborious methods of cutting and fabricating alloy steels.

The key material, used for the tub itself, is nickel-clad steel, which contributes excellent corrosion and wear resistance, and high structural strength, at reasonable cost. Auxiliary parts for the tub units consisted of either nickel-clad or chromium nickel stainless steel. The only cast parts of the machine, from the Black Clawson Foundry, were made of 3% nickel alloy cast iron for the rotor body, and 12 to 14% chromium steel for the rotor pumping vanes to provide wear and abrasion-resistance. Except for the rotor and drive mechanism, the entire machine was fabricated by welding, and it was delivered to the erection site in three sub-assembly sections.

The designers of the Hydrapulper, in planning for all-welded construction, made full use of both that process and its companion process—flame cutting—to work out the most efficient and economical fabrication procedure for building the machine. They were able to realize the full advantages of this familiar steel-working process team through the availability of a new method for flame-cutting stainless steels and related alloys—the flux injection process—recently developed by the Air Reduction Co.

Stainless steels have long defied the oxyacetylene flame, largely because of a layer of refractory oxides formed by the alloying elements as soon as a cut is attempted. These oxides have high melting points,

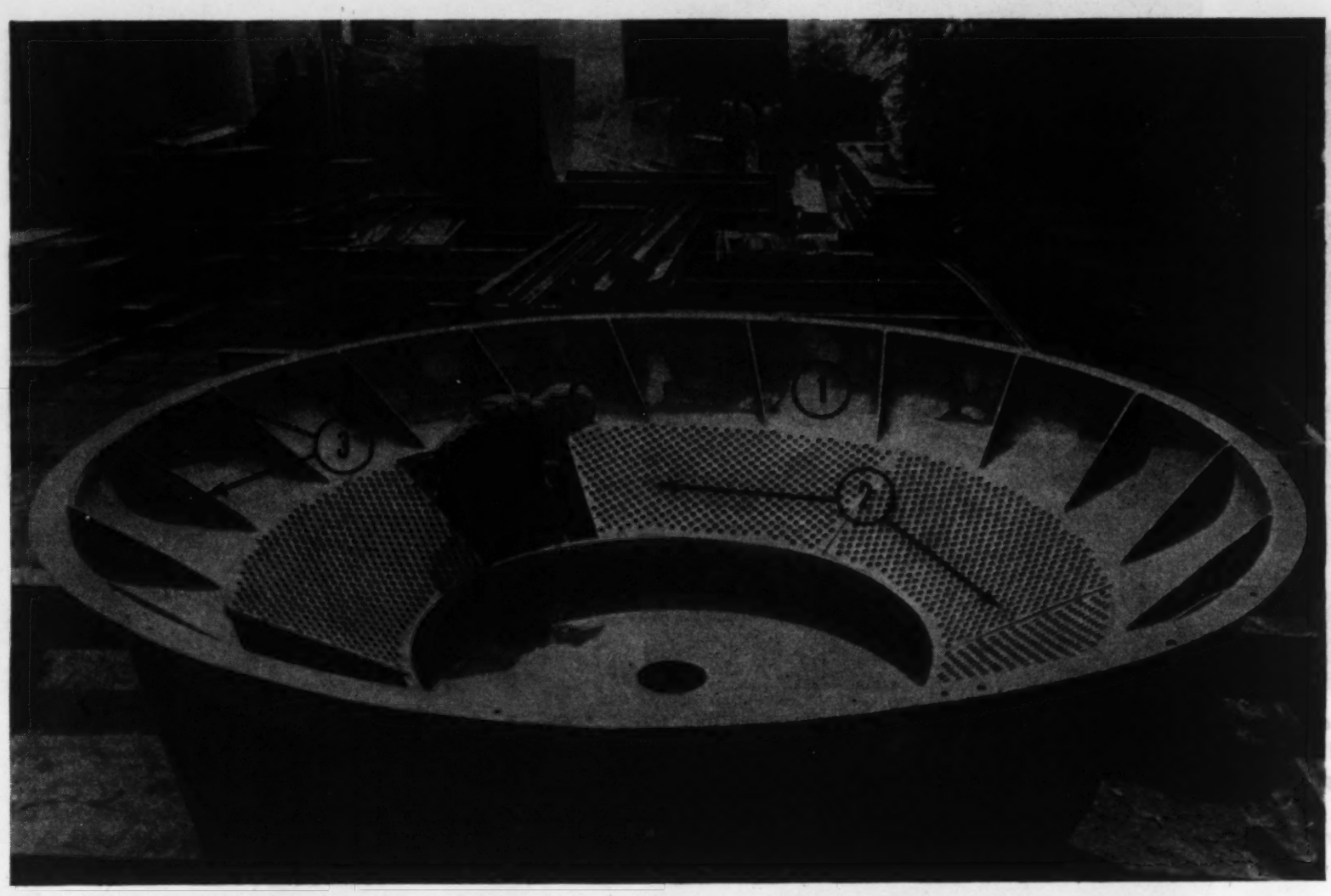


Fig. 4—Base sub-assembly of Hydrapulper almost ready for shipment. Numbers identify parts referred to in text, as follows: (1) Flanged periphery of nickel-clad head, detached by flux-injection cutting; (2) extractor plates fabricated from adjacent inner concentric area of head by flux-injection cutting, flattening, and drilling; (3) vanes cut from type 347 stainless (Figs. 2 and 3) and welded to flange section (Fig. 5). Semi-cylindrical sections in background are prefabricated tub sides ready for fit-up check on base rim. (See Fig. 8).

and do not liquefy and run off as do those of mild steel, so they form a barrier between the cutting torch and the parent metal, effectively stopping the cut. Alternatives to flame-cutting in stainless work have been either makeshift flame-cutting methods, rendering poor quality, or machining, rendering excellent quality at high cost. The flux-injection method strikes at the basic difficulty and fluxes the oxides from the kerf with a special, pulverized, nonmetallic flux which is carried directly by the cutting-oxygen stream from a simple, compact auxiliary device, the Flux Feeder Unit (Fig. 2). Except for this unit, the equipment used is conventional oxyacetylene cutting equipment, although in any such operation where fumes are evolved, it is also necessary to provide adequate ventilation and fume-removal measures to protect the operator and others in the shop.

Cutting speeds and costs with flux-injection compare favorably with those for standard mild steel cutting, and quality is also comparable to mild steel work (Fig. 3). When the cut edges are to be welded, the finished face is ready for fitting up and welding, and if a machined finish is required for other purposes, only a light finishing cut is required; the savings, in either case, make for a healthy reduction in the costs of utilizing such an inherently expensive-to-work material as stainless steel.

Although this process was primarily developed for flame-cutting stainless steel, the Smith & Caffrey Co., who collaborated with the Dilts Machine Works in building the new Hydrapulper, found an additional advantage in flux-injection cutting of nickel-clad steel, scarfing the cut on the nickel side. Excellent dimensional precision was obtained, cutting from the nickel side reduced the risk of spoilage to the cladding from separation or melting away, and the finished edges were well suited for welding without further work.

Most of the flux-injection cutting, and most of the welding, which went into the shop fabrication of the machine were done by the Smith & Caffrey Co., while the cast rotor was produced separately. Of the other three sub-assemblies fabricated by welding, the two semi-cylindrical sides for the tub each consisted only of a nickel-clad plate rolled to precise semi-circular shape, with external stiffeners welded on, while the bulk of the cutting and welding was done on the base unit.

This base was designed around a 12-ft. nickel-clad flanged head, ½-in. thick, with 20% of the thickness on the concave side being pure nickel. One function of sound design—economy in utilization of material—was well demonstrated in the cutting and adaptation of this head. The flanged periphery, to a point just inside the flange-bend, forms the outer ring of the Hydrapulper base sub-

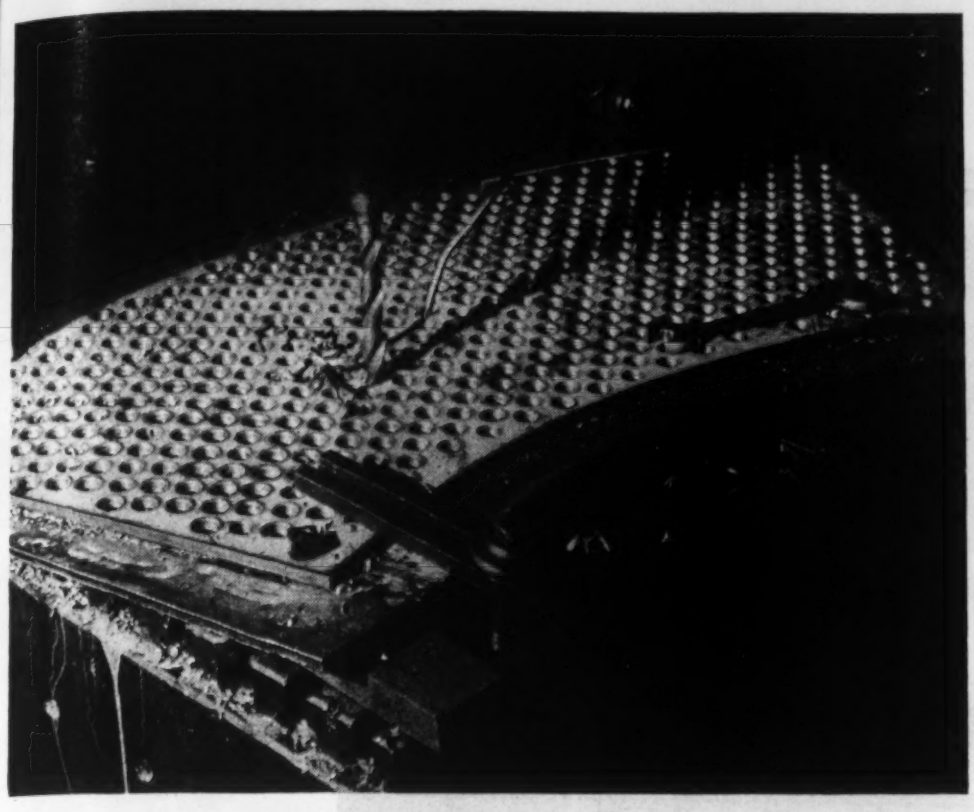


Fig. 5—Drilling an extractor plate, flux-injection cut from the nickel-clad flanged head, and flattened. The clean square edges resulting from the flux-injection cuts, characteristic of the method on clad or stainless steels, are readily apparent.

Fig. 6—Arc welding of type 347 stainless vanes to nickel-clad surface of the flange section from the head, using Inconel electrodes. The quality of the flame-cut on the vane edge is such that further finishing is unnecessary.

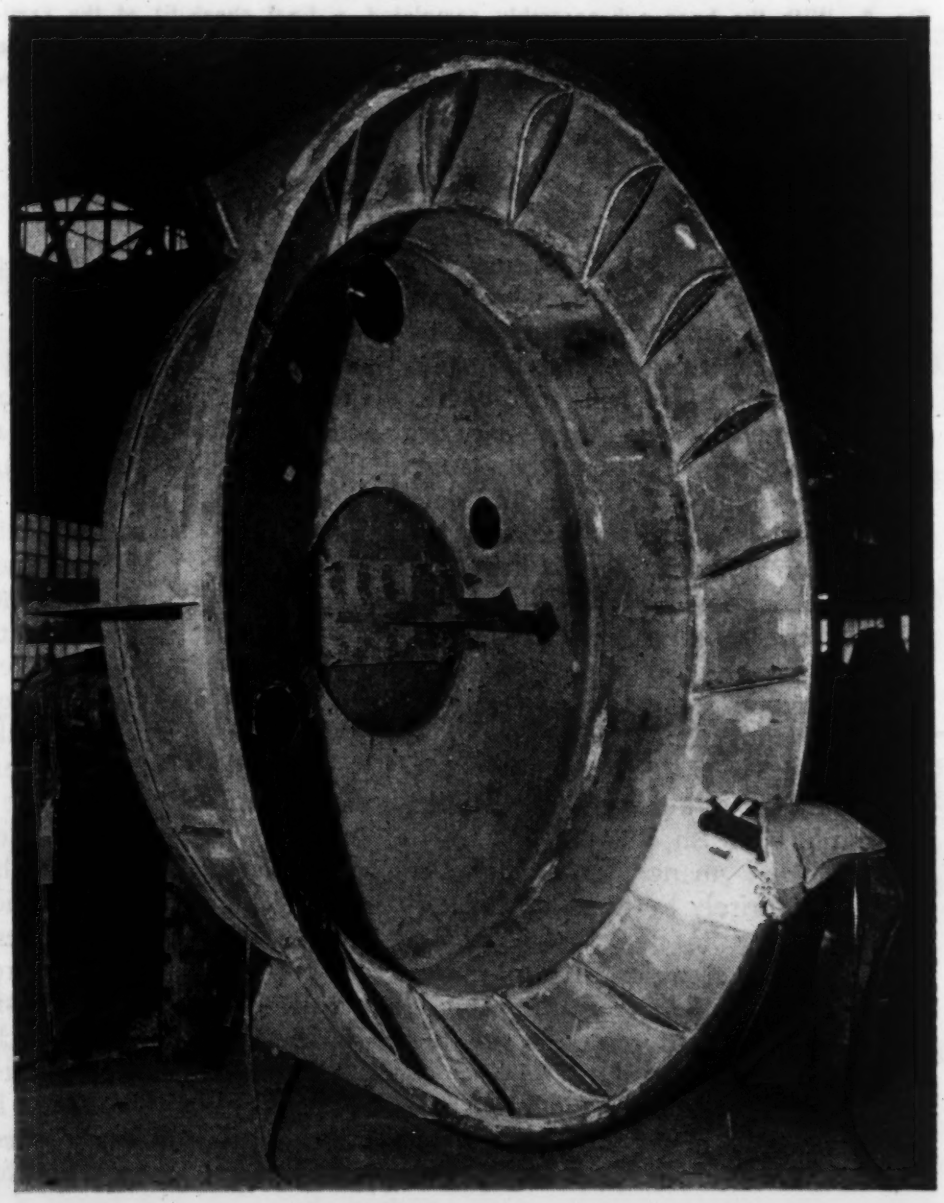


Fig. 7—Base sub-assembly nearing completion. Welding of all joints provided rigidity, leak-proof seams, and speedier fabrication, while flame cutting the parts made possible the speediest preparation of component pieces.

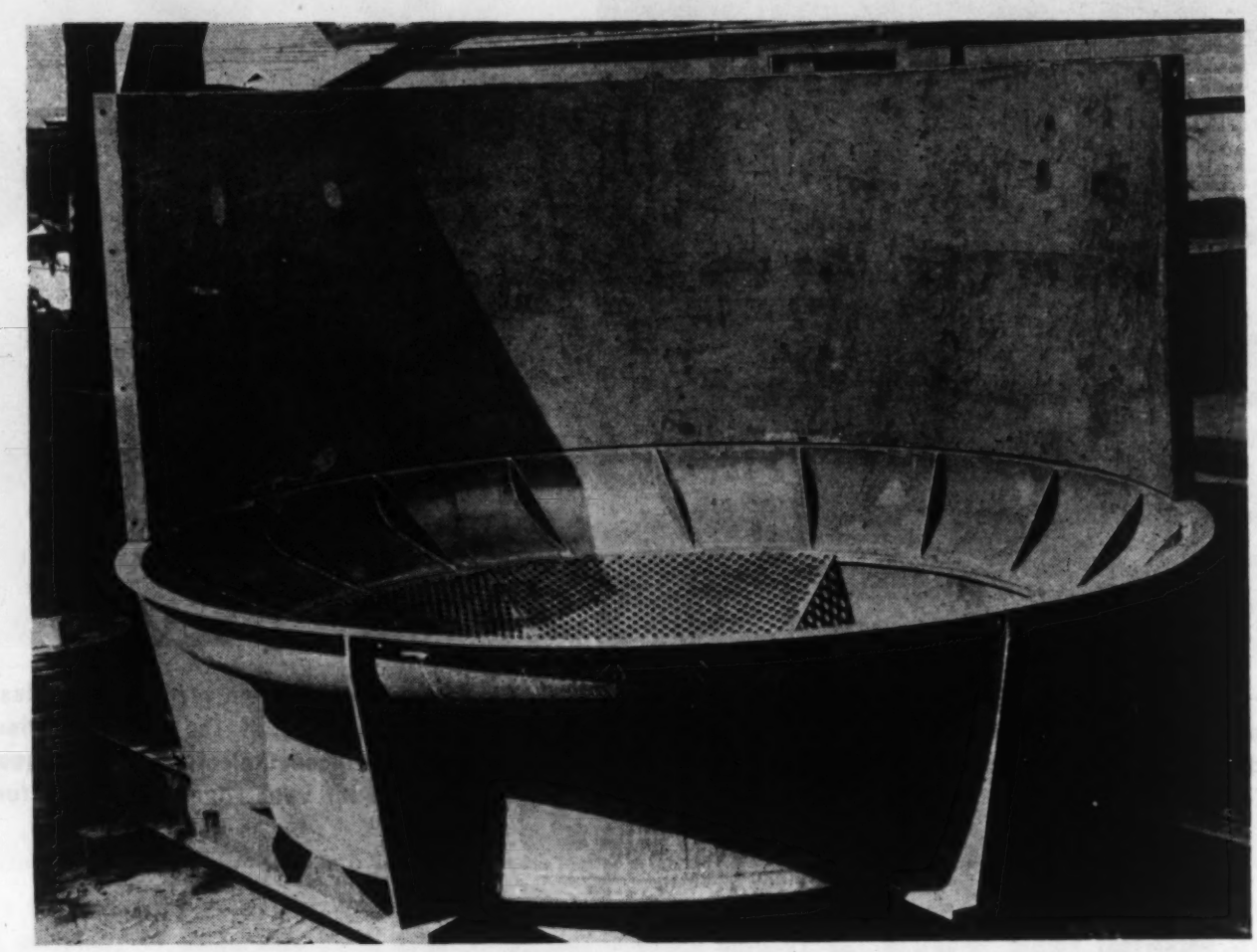


Fig. 8—With the base sub-assembly completed, a final check-fit of the semi-cylindrical tub sides and the extractor plates is made before shipping. With stainless and nickel-clad construction, the entire interior surface of the vessel is corrosion and abrasion resistant.

assembly (Fig. 4, *1*). This ring was detached by flux-injection cutting, using a portable flame-cutting machine with a center point and radius rod. The adjacent concentric ring was cut, again by flux-injection, and further divided radially into six segments. These segments were then flattened and drilled (Fig. 5) to form the extractor plates in the bottom of the tub (Fig. 4, *2*). Thus, the entire flanged and dished head was utilized for this fabrication.

Although no such high utilization of the original plate area is possible with the less adaptable contours of the stainless steel vanes which are welded into the flanged periphery of the base (Fig. 6), shrewd layout and skillful operation of the flux-injection equipment reduced scrap loss from the ⅜-in., type 347 plate to a minimum (Fig. 3). These vanes were cut in a few minutes apiece, on a standard Oxygraph, to finish contour.

These, and many other flame-cut parts, were assembled entirely by welding (Fig. 7) using nickel electrodes for the nickel-to-nickel and Inconel for stainless-to-nickel welds, and mild steel rods for the welds in the mild steel side, into the base sub-assembly. Before shipping, the side plates for the tub proper were fitted to the base as a check (Fig. 8), and were then ready for field assembly by welding. With two side plates, the sub-assembled base, and the cast rotor, the machine was then shipped in only four main parts, saving shipping time, space and weight, and minimizing the possibility of damage en route.

The field erection of the machine was further simplified by the small number of units to be assembled, and the few joints to be made at the site. Leveling up, setting the additional sections in place, and a relatively small amount of welding completed the job (Figs. 1 and 9).

The all-welded construction makes the Hydrapulper a more rigid structure throughout, cutting down vibration, eliminating bolts and screws that might shake loose, and provides water-tight seams which prevent leaks at the joints, eliminating the need for calking. Welding, with its companion technique of flame cutting by flux-injection, also made possible the speedy, economical fabrication of the most suitable materials to meet the service conditions under which the machine operates. Nickel-clad to resist abrasion and corrosion at moderate material cost, stainless steels where both sides of a piece must be protected, and nickel alloy cast iron for abrasion resistance, all played a part in the design of the machine. These modern materials, handled and fabricated by low-cost modern methods, make this newest Hydrapulper the most unique among the many predecessor machines already in use in the paper industry.

International Amphitheatre, Chicago, scene of the 1947 Metals Show.

Preview of

NATIONAL METAL CONGRESS AND EXPOSITION

CHICAGO, ILLINOIS OCTOBER 18 THROUGH 24, 1947

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Introduction

To Chicago in mid-October (October 18th to 24th, to be exact), from all over this country, from our Pan-American neighbors and from abroad, will come thousands of metallurgists, engineers and manufacturers seeking education and entertainment on the occasion of the 29th annual National Metal Congress and Exposition, generally known as "The Metal Show." Clutching membership cards, hotel reservations, return railroad tickets, meeting programs, Amphitheatre floor plans, nocturnal-party invitations, metal parts to be treated or cut or brazed or broken, loop magnifiers, portable hardness testers and combination teeth-brushers-and-electric-shavers, they will wind the Windy City into metallurgical knots and leave it gasping for another four or five years.

This 1947 Metal Show promises to be the most "orderly" of the modern series. The A.S.M. has rigidly limited the number of papers to be presented, so that the program as a whole can be enjoyed without the feeling of frustration attendant on trying to be in three different places simultaneously. A good representation of materials and equipment manufacturers will exhibit, with the nonferrous producers again dominating the metal exhibits and the gas-equipment clan's combined exhibit representing, it is expected, the largest block of space at the exposition.

The Exposition this year will be a seven-day, rather than a five-day affair, and will run the full period from October 18 to 24. It promises to have all the ingredients that have in previous years attracted thousands of members of the metals industries. The latest developments in materials, processes and equipment for the metal working industries will be displayed with the help of every conceivable visual aid including movies, working models, demonstrations and pretty girls.

At the conventions, of course, there will also be the more sober technical sessions, and the lavish annual dinners of the participating societies.

The side attractions will as always compete with the main attractions for attention—meeting old friends and/or customers; seeing the night life of Chicago; and visiting the bars that are set up in hotel suites. And because Chicago is a major center of the metal industries, an exceptionally well-attended show is expected with the official predictions running around 20,000. All in all it should be one of the best Metal Shows yet.

Below a brief resume of the main events is given.

Participating Societies

As in previous years, the American Society for Metals is sponsoring the event and three other organizations are participating with technical meetings during the week. They are the American Welding Society, the Iron & Steel Division and the Institute of Metals Division of the American Institute of Mining & Metallurgical Engineers, and the American Industrial Radium & X-Ray Society. The American Society of Metals has also arranged a technical program.

The Exposition

The exposition this year is expected to have somewhere between 300 and 400 exhibits which will take up the floor space on both levels of the International Amphitheatre. The exhibits will include the latest developments in materials and methods and equipment for the metal working industries.

This year the exposition will be held two extra days and marks the first time that it will run longer than five days. Two additional days have been added to the schedule because of the large number of interested technical personnel in the Chicago area who are expected to take advantage of the week-end opening of the exposition.

The exposition will open at 12 noon daily and close at 10:00 P.M., except Thursday and Friday when the exhibit will open at 10:00 A.M. and close at 6:00 P.M.

American Society for Metals

The American Society for Metals can always be counted on to have an interesting and timely program. In line with their policy of keeping their members up-to-date on atomic energy developments, the Society will have a session on the metallurgical requirements of the atomic energy and power production. The session will be under the auspices of the Atomic Energy Commission, and will be held on Wednesday evening at the Palmer House. Leading scientists on the staff of the commission will participate.

Another timely and very important subject will be covered in a special seminar Saturday and Sunday, October 18 and 19, at the Palmer House. The subject is the Fundamental Relations in the Fracturing of Metals and will be discussed in a series of six panel meetings by twenty-one leaders in the field.

Besides these highlights, there will be the regular program of technical papers running Monday through Friday. The current interest in high temperature alloys and properties of metals at both high and low temperatures is reflected in the attention given to them in the technical sessions. Other topics on which papers will be presented include heat treating, light and other nonferrous metals, metalworking and testing, and steelmaking.

The annual meeting of the Society will be held Wednesday morning at which time announcement of the new officers of the Society will be made. They are: Francis B. Foley, President; Harold K. Work, Vice-President; E. L. Spanagel, Treasurer. At the same session the Edward de Mille Campbell Memorial Lecture will be delivered by A. B. Kinzel, Electro Metallurgical Co.

On Thursday evening the annual banquet will be held at the Palmer House. Features of the dinner will be awarding the ASM Gold Medal to Dr. C. H. Mathewson, Professor of Metallurgy at Yale University, for his work in advancing the application of science to the metal industry, and the Albert Sauveur Award to F. P. Zimmerli.

Metals Divisions, AIME

The Institute of Metals and the Iron & Steel Divisions of the American Institute of Mining & Metallurgical Engineers will again hold their fall meeting the first three days of the week, October 20 to 22. There will be separate technical sessions by each group and also two joint meetings. The technical sessions of the Institute of Metals Division include papers on copper and copper alloys, light metals, and recrystallization and grain growth. The Iron & Steel Division will have sessions on steel making and metallography. The joint sessions will include papers on surface films and corrosion. The annual Fall Dinner will be at the Stevens Hotel on Tuesday evening.

American Welding Society

A number of events are featured in the AWS program. On Sunday evening, October 19, will be President L. W. Delhi's reception. The awards of prizes and medals will be made on Monday evening at which time the Adams Lecture will be given by G. S. Mikhalapov, Air Reduction Sales Co. The annual banquet will be held on Thursday evening. All these functions will take place in the Hotel Sherman. Special welding and cutting exhibits and demonstrations will be held at the International Amphitheatre during the entire exposition.

The technical sessions will cover practically all the important phases of welding. There will be sessions on various types of welding and cutting; also meetings concerned with the problems of welding specific materials, including alloy steels and nonferrous alloys. In addition, there will be four sessions on research and two of these will be devoted to the recent work done on welded ship structures.

American Industrial Radium & X-Ray Society

The annual meeting of the Society will be held Thursday afternoon at the Morrison Hotel. Dr. Leslie W. Ball, Naval Ordnance Laboratory will deliver the Lester Lecture on non-destructive testing of naval ordnance.

At the annual meeting the name of the Society will be officially changed to the Society for Non-Destructive Testing. The name change indicates broadening of the society's field to include other methods of non-destructive testing besides radiography, and the sessions will include papers on spectroscopy and the application of electronics to non-destructive testing.

NATIONAL METAL CONGRESS AND EXPOSITION

Consolidated Program

Given here is a consolidated program listing the activities of the four participating societies. The events are integrated chronologically, so that the reader can see at a glance what sessions are occurring simultaneously at any specific time.

Saturday, October 18

10:00 A.M. **ASM** ..... *Seminar on Metal Fractures.* Palmer House.
2:00 P.M. **ASM** ..... *Seminar on Metal Fractures.* Palmer House.
8:00 P.M. **ASM** ..... *Seminar on Metal Fractures.* Palmer House.

Sunday, October 19

9:00 A.M. **ASM** ..... *Seminar on Metal Fractures.* Palmer House.
2:00 P.M. **ASM** ..... *Seminar on Metal Fractures.* Palmer House.
5 - 7 P.M. **AWS** ..... *President's Reception.* Louis XVI Room, Hotel Sherman.
8:00 P.M. **ASM** ..... *Seminar on Metal Fractures.* Palmer House.

Monday, October 20

9:30 A.M. **AWS** ..... *General Papers.* Ballroom, Hotel Sherman.
AWS ..... *Railroad Welding.* Louis XVI Room, Hotel Sherman.
AWS ..... *Air Conditioning and Refrigerators.* Crystal Room, Hotel Sherman.
10:00 A.M. **ASM** ..... *Tempered Chromium-Silicon Spring Steel; Hardenability of Boron Steels; Tempering Effects and Mechanical Equation of State.* Ballroom, Palmer House.
AIME .... **Institute of Metals.** *Copper and Copper Alloys.* North Ballroom, Stevens Hotel.
2:00 P.M. **ASM** ..... *Induction Hardening Session.* Amphitheatre.
AIME .... **Institute of Metals.** *Recrystallization and Grain Growth.* Private Dining Room 2, Stevens Hotel.
AIME .... **Iron & Steel Division.** *Metallography.* North Ballroom, Stevens Hotel.
4:15 P.M. **ASM** ..... *Educational Lecture: Physical Metallurgy.* Amphitheatre.
8:00 P.M. **ASM** ..... *Educational Lecture: Physical Metallurgy.* Amphitheatre.
Evening **AWS** ..... *Adams Lecture and Awards Presentation.* Hotel Sherman.

Tuesday, October 21

9:30 A.M. **AWS** ..... *Pressure Vessels.* Louis XVI Room, Hotel Sherman.
AWS ..... *Miscellaneous Papers.* Crystal Room, Hotel Sherman.
AWS ..... *Research.* Ballroom, Hotel Sherman.
AIME .... **Institute of Metals.** *Light Metals.* Private Dining Room, Stevens Hotel.
AIME .... **Iron & Steel Division.** *Steelmaking.* North Ballroom, Stevens Hotel.
10:00 A.M. **ASM** ..... *Dimensional Stability of Steel; Beryllium and Aluminum Alloy Sheet.* Red Laquer Room, Palmer House.
2:00 P.M. **ASM** ..... *Location of Alloying Metals in White Cast Iron; Graphitization of Steel; Hydrogen Potential in Steam-Metal Reactions.* Amphitheatre.
AIME .... **Joint Session.** *Surface Films and Corrosion.* North Ballroom, Stevens Hotel.
AWS ..... *Pipe and Maintenance Welding.* Louis XVI Room, Hotel Sherman.

Consolidated Program

(Tuesday, October 21, Continued)

AWS ..... *Research.* Ballroom, Hotel Sherman.
AWS ..... *High Alloys.* Crystal Room, Hotel Sherman.
4:15 P.M. **ASM** ..... *Educational Lecture: Physical Metallurgy.* Amphitheatre.
7:00 P.M. **AIME** .... *Annual Fall Dinner.* Upper Tower Room, Stevens Hotel.
7:45 P.M. **AWS** ..... *University Research Conference.* Hotel Sherman.
8:00 P.M. **ASM** ..... *Educational Lecture: Physical Metallurgy.* Amphitheatre.

Wednesday, October 22

9:30 A.M. **AWS** ..... *Resistance Welding.* Louis XVI Room, Hotel Sherman.
AWS ..... *Cutting.* Ballroom, Hotel Sherman.
AWS ..... *Ship Structures Research.* Crystal Room, Hotel Sherman.
AIRXS .. *Mass X-Ray Inspection; Skin Thickness in Bronze Castings; Stereo-Microradiography.* Hotel Morrison.
10:00 A.M. **ASM** ..... *Annual Meeting and Campbell Memorial Lecture.* Ballroom, Palmer House.
12:00 Noon **ASM** ..... *Alumni Luncheons.* Palmer House.
2:00 P.M. **ASM** ..... *Heat Resistant Alloys; Hot-Dipped Galvanized Coatings.* Amphitheatre.
AIME .... **Joint Session.** *General Session.* North Ballroom, Stevens Hotel.
AWS ..... *Resistance Welding.* Louis XVI Room, Hotel Sherman.
AWS ..... *Nonferrous.* Crystal Room, Hotel Sherman.
AWS ..... *Ship Structures Research.* Ballroom, Hotel Sherman.
AIRXS .. *Exposure Slide Rule for Radium; Isotypes in Industrial Radiography; X-Ray Diffraction.* Hotel Morrison.
4:15 P.M. **ASM** ..... *Educational Lecture: Copper and Copper Alloys.* Amphitheatre.
8:00 P.M. **ASM** ..... *Educational Lecture: Copper and Copper Alloys.* Amphitheatre.
8:30 P.M. **ASM** ..... *Atomic Energy Session.* Palmer House.

Thursday, October 23

9:30 A.M. **AWS** ..... *Alloy Steels.* Louis XVI Room, Hotel Sherman.
AWS ....., *Miscellaneous.* Crystal Room, Hotel Sherman.
AWS ..... *Structural.* Ballroom, Hotel Sherman.
AIRXS .. *Spectroscopy and X-Ray Diffraction; Automatic Processing of X-Ray Film; Influence of Field Size on Contrast and Exposure.* Hotel Morrison.
10:00 A.M. **ASM** ..... *Low Temperature Properties of Metals; Influence of Metallurgical Factors on Properties of Steel; Fatigue Strength of Binary Ferrites.* Ballroom, Palmer House.
12:00 Noon **ASM** ..... *Canadian Luncheon.* Palmer House.
2:00 P.M. **ASM** ..... *Bend Test for Hardened High-Speed Steel; Effects of Grinding on Hardened Steel Parts; Shot Peening.* Amphitheatre.
AIRXS .. *Annual Meeting and Lester Lecture.* Hotel Morrison.
6:30 P.M. **AWS** ..... *Annual Banquet.* Grand Ballroom, Mezzanine, Hotel Sherman.
7:00 P.M. **ASM** ..... *Annual Banquet.* Palmer House.

Friday, October 24

9:30 A.M. **AWS** ..... *Inert Gas Welding.* Louis XVI Room, Hotel Sherman.
AIRXS .. *Radiography of Die Castings; Electronic Non-Destructive Testing; Million Volt Radiography.* Hotel Morrison.
10:00 A.M. **ASM** ..... *Steel Plant Session.* Ballroom, Palmer House.
2:00 P.M. **ASM** ..... *Austenite Grain Size in Heat Treated Cast Alloy Steels; Silicon in Cast Carbon and Carbon-Molybdenum Steels; Homogenization of Cast Steels.* Amphitheatre.
AWS ..... *Business Session.* Crystal Room, Hotel Sherman.
AIRXS .. *Million and Multi-Million Volt Radiography.* Hotel Morrison.
4:15 P.M. **ASM** ..... *Educational Lecture: Copper and Copper Alloys.* Amphitheatre.
8:00 P.M. **ASM** ..... *Educational Lecture: Copper and Copper Alloys.* Amphitheatre.

Society Headquarters

For quick reference, here are the Metal Show headquarters and meeting places for the technical sessions of the participating societies:

American Society for Metals—Palmer House and International Amphitheatre

American Institute of Mining & Metallurgical Engineers—Stevens Hotel

American Welding Society—Hotel Sherman

American Industrial Radium & X-Ray Society—Hotel Morrison

AMERICAN SOCIETY FOR METALS: Technical Program

The American Society for Metals will have ten technical sessions consisting of 30 papers. In addition, the popular Education Lecture Courses will again be held. There will be eight lectures covering two topics of current interest. A special seminar on "Fundamental Relations in the Fracturing of Metals" will be held Saturday and Sunday at the Palmer House. The annual banquet will be Thursday evening.

The morning technical sessions will be held at the Palmer House and the afternoon sessions at the Amphitheatre.

Saturday, October 18

Morning—10:00 A.M.

General Introduction, by Maxwell Gensamer, Pennsylvania State College.

The Micro-Mechanisms of the Initiation of Fracture, by Clarence Zener, University of Chicago.

Effects of Stress State on Fracture, by J. E. Dorn, University of California.

Saturday, October 18

Afternoon—2:00 P.M.

Effects of Strain on Fracture, by George Sachs, Case Institute of Technology.

Effects of Structure on Fracture, by J. H. Hollomon, General Electric Co.

Metallurgical Aspects of Brittle Fracture Phenomena in Structures, by I. G. Slater, British Admiralty Delegation.

Effects of Section Size on Fracture, by E. R. Parker, University of California.

Saturday, October 18

Evening—8:00 P.M.

Fracture Dynamics, by George Irwin, Naval Research Laboratory.

Reduction of Data on Ductility of Steel, by W. P. Roop, Swarthmore College.

Fracturing Characteristics of Low-Carbon Steel, by P. Shearin, North Carolina University.

Sunday, October 19

Morning—9:00 A.M.

Fracture and Hydrostatic Pressure, by P. W. Bridgman, Harvard University.

Notch Bar Tensile Testing, by J. D. Lubahn, General Electric Co.

Report on Conference on Mechanical Properties of Solids at the University of Bristol, by P. Symonds or N. F. R. Nabarro, Naval Research Laboratory.

Sunday, October 19

Afternoon—2:00 P.M.

New Testing Machines for Combined Stress Experiments, by J. Martin, Pennsylvania State College.

Time Effect in the Fracture of Materials, by E. Saibel, Carnegie Institute of Technology.

Dislocation Theory of the Fatigue of Metals, by E. S. Machlin, National Advisory Committee for Aeronautics.

Sunday, October 19

Evening—8:00 P.M.

Projected Experimental Study of the General Laws for Deviation from Elastic Behavior Under Combined Stresses, by L. H. Donnell, Illinois Institute of Technology.

Correlations Between the Fracture of Metals in Shear with Their True Stress-Strain Properties, by T. A. Read, Frankford Arsenal.

Monday, October 20

Morning—10:00 A.M.

An Investigation of Tempered Chromium-Silicon Spring Steel, by H. J. Elmendorf, American Steel & Wire Co.

The Effect of Carbon Content on the Hardenability of Boron Steels, by G. D. Rahrer & C. S. Armstrong, Carnegie-Illinois Steel Corp.

Tempering Effects and the Mechanical Equation of State, by J. C. Fisher & C. W. MacGregor, Massachusetts Institute of Technology.

Monday, October 20

Afternoon—2:00 P.M.

The Induction Hardening of a Quality Controlled Cast Iron, by C. F. Walton, Meehanite Metal Corp., & H. B. Osborn, Jr., Ohio Crankshaft Co.

Some Factors Affecting the Induction Hardening of an Alloy Cast Iron, by J. R. Sloan & R. H. Hays, Caterpillar Tractor Co.

A Study of the Metallurgical Characteristics of Three Induction-Hardened Steels Heated at Various Rates, by James W. Poynter, Wright Field.

Tuesday, October 21

Morning—10:00 A.M.

SESSION No. 1

The Dimensional Stability of Steel—Part II—Further Experiments on Subatmospheric Transformations, by S. G. Fletcher, Latrobe Electric Steel Co., and B. L. Averbach & M. Cohen, Massachusetts Institute of Technology.

The Dimensional Stability of Steel—Part III—Decomposition of Martensite and Austenite at Room Temperature, by B. L. Averbach & M. Cohen, Massachusetts Institute of Technology, & S. G. Fletcher, Latrobe Electric Steel Co.

Acicular Transformations in Alloy Steel, by E. A. Loria, Mellon Institute of Industrial Research.

SESSION No. 2

Beryllium in Magnesium Casting Alloys, by Jay R. Burns, Wright Field.

The Heat Treatment and Properties of Some Beryllium-Nickel Alloys, by W. Lee Williams, U. S. Naval Engineering Experiment Station.

Stretching Characteristics of Aluminum Alloy Sheet, by J. M. Taub, Los Alamos Scientific Lab.

Tuesday, October 21

Afternoon—2:00 P.M.

The Location of Alloying Metals in White Cast Iron, by H. A. Schwartz & James Hedberg, National Malleable & Steel Castings Co.

Graphitization of Steel at Elevated Temperatures, by A. B. Wilder & J. D. Tyson, National Tube Co.

Concept of the Hydrogen Potential in Steam-Metal Reactions, by Carl A. Zapffe, Baltimore.

Wednesday, October 22

Morning—10:00 A.M.

ASM ANNUAL MEETING

Edward de Mille Campbell Memorial Lecture, by A. B. Kinzel, Electro Metallurgical Co.

Educational Lecture Courses

INTRODUCTORY PHYSICAL METALLURGY

Four Lectures by C. W. Mason, Cornell University, Monday and Tuesday, Oct. 20 and 21, both days at 4:15 and 8:00 P.M.

COPPER AND COPPER ALLOYS

Three Lectures by O. W. Ellis, Ontario Research Foundation, Wednesday, October 22, 4:15 and 8:00 P.M.; Thursday, October 23, 4:15 P.M.

Wednesday, October 22

Afternoon—2:00 P.M.

Cast Heat Resistant Alloys of the 26% Cr, 20% Ni Type-I, by H. S. Avery & C. R. Wilks, American Brake Shoe Co.

The Cobalt-Chromium J Alloy at 1350 to 1800 F, by N. J. Grant, Massachusetts Institute of Technology.

Metallography of Hot-Dipped Galvanized Coatings, by D. H. Rowland, Carnegie-Illinois Steel Corp.

Wednesday, October 22

Evening—8:30 P.M.

Metallurgical Requirements of the Atomic Energy and Power Production Program.

Thursday, October 23

Morning—10:00 A.M.

Mechanical Properties of Metals at Low Temperatures; A Survey, by L. Seigle & R. M. Brick, University of Pennsylvania.

Influence of Metallurgical Factors on the Mechanical Properties of Steel, by S. A. Herres & C. H. Lorig, Battelle Memorial Institute.

The Fatigue Strength of Binary Ferrites, by E. Epremian, General Electric Co., & E. F. Nippes, Rensselaer Polytechnic Institute.

Thursday, October 23

Afternoon—2:00 P.M.

The Bend Test for Hardened High-Speed Steel, by A. H. Grobe & G. A. Roberts, Vanadium-Alloys Steel Co.

Effects of Grinding on Physical Properties of Hardened Steel Parts, by H. E. Boyer, American Bosch Corp.

Recrystallization as a Measurement of Relative Shot Peening Intensities, by K. B. Valentine, Pontiac Motor Div., General Motors Corp.

Friday, October 24

Morning—10:00 A.M.

Macro-Segregation in Some Alloy Steel Ingots, by J. W. Spretnak, Carnegie Institute of Technology.

The Distribution of Oxygen and Nitrogen in an Alloy Steel Ingot, by C. F. Sawyer, J. W. Spretnak & G. Derge, Carnegie Institute of Technology.

Multiple Correlation Applied to Steel Plant Problems, by W. T. Rogers, National Tube Co.

Friday, October 24

Afternoon—2:00 P.M.

Detection of As-Cast Austenite Grain Size in Heat Treated Cast Alloy Steels, by E. A. Loria, Mellon Institute of Industrial Research.

The Effect of Silicon on the Properties of Cast Carbon and Carbon-Molybdenum Steels, by N. A. Ziegler, W. L. Meinhart & J. R. Goldsmith, Crane Co.

The Effect of Homogenization on Cast Steels, by R. J. Marcotte & C. T. Eddy, Michigan College of Mining & Technology.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS: Technical Program

The Institute of Metals and Iron & Steel Divisions will have their technical sessions the first three days of the week. A total of 22 papers will be presented. The annual Fall dinner will be held Tuesday evening.

All of the functions will be held at the Stevens Hotel.

Institute of Metals Division

Monday, October 20

Morning—10:00 A.M.

COPPER AND COPPER ALLOYS

Some Observations of Lineage in Copper Crystals, by W. R. Hibbard, Jr.

The Isothermal Transformation of a Eutectoid Aluminum Bronze, by D. J. Mack.

Preferred Orientations in Drawn and Annealed 70-30 Alpha Brass Tubes, by W. R. Hibbard, Jr.

Monday, October 20

Afternoon—2:00 P.M.

RECRYSTALLIZATION AND GRAIN GROWTH

The Comparative Properties of Several Types of Commercial Coppers as Cold-Worked and as Recrystallized, by L. R. Jackson, A. M. Hall & A. D. Schwope.

The Effect of Mechanical Deformation on Grain Growth in Alpha Brass, by J. E. Burke & Y. G. Shiau.

Grain Growth in High-Purity Aluminum and in an Aluminum-Magnesium Alloy, by P. A. Beck, J. C. Kremer, L. J. Demer & M. L. Holzworth.

Tuesday, October 21

Morning—9:30 A.M.

LIGHT METALS

Vacuum Process for Preparation of Lithium Metal from Spodumene, by R. G. Stauffer.

Purification of Aluminum and Its Alloys, by Y. Dardel.

Quenching of 75S Aluminum Alloys, by W. L. Fink & L. A. Willey.

Factors Involved in Heat-Treating a Magnesium Alloy, by A. E. Flanigan, I. I. Cornet, R. Hultgren, J. T. Lapsley & J. E. Dorn.

Tuesday, October 21

Afternoon—2:00 P.M.

Joint Session with Iron & Steel Division

SURFACE FILMS AND CORROSION

Passivity of Chromium-Iron Alloys; Absorbed Iron Films on Chromium, by H. H. Uhlig.

Thin Oxide Films on Molybdenum, by E. A. Gulbransen & W. S. Wysong.

Thin Oxide Films on Tungsten, by E. A. Gulbransen & W. S. Wysong.

Effect of Tension and Compression on the Corrosion of an Aluminum Alloy, by W. D. Robertson.

Wednesday, October 22

Afternoon—2:00 P.M.

Joint Session with Iron & Steel Division

GENERAL SESSION

Plating Molybdenum, Tungsten and Chromium by Thermal Decomposition of Their Carbonyls, by J. J. Lander & L. H. Germer.

An Electrolytic Method for Pointing Tungsten Wires, by W. G. Pfann.

Tantalum Powder by Magnesium Reduction, by J. Prieto Isaza, A. J. Shaler & John Wulff.

Iron & Steel Division

Monday, October 20

Afternoon—2:00 P.M.

METALLOGRAPHY

Austenite Transformation Above and Within the Martensite Range, by R. T. Howard, Jr. & M. Cohen.

Behavior of Metal Cavity Liners in Shaped Explosive Charges, by G. B. Clark & W. H. Bruckner.

Testing Gun Steel and Other Alloys and Metals for Resistance to Surface Cracking, by E. Ingerson.

Tuesday, October 21

Morning—9:30 A.M.

STEELMAKING

Structure, Segregation and Solidification of Semikilled Steel Ingots, by M. Tennenbaum.

Tuesday, October 21 Wednesday, October 22

Afternoon—2:00 P.M.

JOINT SESSION

(See Institute of Metals Division)

AMERICAN WELDING SOCIETY: Technical Program

The technical sessions of the American Welding Society include a total of 70 papers covering 16 classifications of welding applications and research. All technical sessions will be held at the Hotel Sherman. In addition to the technical sessions, there will be welding and cutting exhibits at the exposition amphitheatre every day, Saturday through the following Friday, 12 noon to 10:30 P.M. except Thursday and Friday, when they will be held from 10:00 A.M. to 6:00 P.M.

The annual banquet will be held Thursday evening at the Hotel Sherman.

Monday, October 20

Morning—9:30 A.M.

GENERAL

Directional Welding to Minimize or Eliminate Distortion in Weldments and Control Residual Stresses, by Joseph Holt, Webster Brinkley Co.

Precision Pressure Regulation of Various Gases, by J. K. Hamilton, Air Reduction Sales Co.

Welded Fabrication, by Ray Stitt, R. C. Mahon Co.

RAILROAD

Flame-Hardening Locomotive Brake and Spring Rigging Pins and Bushings, by B. W. Covell, Northern Pacific Railway Co.

End-Hardening of Rails and Open-Hearth Frogs, by R. W. Torbert, The Oxweld Railroad Service Co.

New Developments in Railroad Maintenance-of-Way Work, by C. A. Daley, Air Reduction Sales Co.

Problems in Resistance Welding Stainless Steel Railway Car Structures, by J. Van den Beemt, The Budd Co.

AIR CONDITIONING AND REFRIGERATORS

Welding in Assembly Line Production of Refrigerator Cabinets, by P. Bowman, Seeger Refrigerator Co.

High-Speed Automatic Oxyacetylene Welding, by H. O. Jones, Air Reduction Sales Co.

Evening

Structural Strength of the Welded Joint, by G. S. Mikhalapov, Air Reduction Sales Co.

Tuesday, October 21

Morning—9:30 A.M.

PRESSURE VESSELS

Welding of Locomotive-Type High-Pressure Boilers, by George M. Trefts, Farrar & Trefts, Inc.

Carbon Arc Welding of Copper Pressure Vessels, by John J. Vreeland, Chase Brass & Copper Co.

Integral Cast Bosses for Pressure Vessels, by Dr. H. L. Anthony & H. P. Schane, Scaife Co.

Development of Butt-Welded Joints in Pressure Vessels, by Edwin J. Brown, Union Iron Works.

MISCELLANEOUS

Multi-Flame Pressure Welding Process, by N. H. Cuke, Canadian Liquid Air Co., Ltd.

Controlled Low-Temperature Stress-Relieving of Welded Tanks for Wet Seal Gas Holder, by R. Kraus, Stacey Bros., Gas Construction Co.

Composite Alloy Fabrication with the Hidden Arc, by H. E. Cable, Lincoln Electric Co.

Semi-Automatic Welding with Standard Manual Arc-Welding Equipment, by F. W. Myers, Jr., Watertown Arsenal.

RESEARCH

Determination of Physical Chemical Factors in Stress Corrosion Cracking of Mild Steel, by H. J. McDonald & M. G. Winterstein, Illinois Institute of Technology.

Distribution of Strength and Ductility in Welded Steel Plate as Revealed by the Static Notch Bar Tensile Test, by W. F. Brown, Jr., L. J. Ebert & G. Sachs, Case School of Applied Science.

Some Unusual Features Encountered in the Investigation of Cracked Welds in 35/15 Magnesium Retorts, by H. J. Nichols, Dept. of Mines and Resources, Canada.

Tuesday, October 21

Afternoon—2:00 P.M.

PIPE AND MAINTENANCE WELDING

Metallurgical Properties of High-Strength Seamless Line Pipe, by A. B. Wilder & J. D. Tyson, National Tube Co.

Building, Repairing and Design of Farm Machinery, by Ernest J. Koop, Ernest J. Koop Welding & Blacksmith Shop.

The Maintenance Welder, Its Equipment, Supplies, Organization and Methods, by Cleo E. Hook, Noblett Sparks Industries, Inc.

RESEARCH

The Effect of Titanium and Vanadium on the Physical Properties and Weldability of High-Tensile Structural Steel, by George G. Luther, Donald B. Roach & Carl E. Hartbower, Naval Research Lab.

Effects of Section Size on the Static Notch Bar Tensile Properties of Mild Steel Plate, by L. J. Ebert, W. F. Brown, Jr. & G. Sachs, Case School of Applied Sicence.

Low Temperature Charpy Tests of Various Ferritic Weld Deposits, by W. B. Bunn, The M. W. Kellogg Co.

HIGH ALLOYS

Welding and Fabrication of High-Temperature Alloys, by C. G. Chisholm, Haynes Stellite Co.

Some Factors Controlling the Ductility of 25 Cr, 20 Ni Weld Deposits, by O. R. Carpenter & N. C. Jessen, Babcock & Wilcox Co.

Selection of Austenitic Electrodes for Welding Dissimilar Metals, by Anton L. Schaeffler, Arcos Corp.

Wednesday, October 22

Morning—9:30 A.M.

RESISTANCE WELDING

Flash Welding of the Structural Aluminum Alloys, by R. Condit Becker & Robert M. Curran, Rensselaer Polytechnic Institute.

The Metallurgy of Carbon Steel Spot Welding (0.01 to 1.00 C), by Julius Heuschkel, Westinghouse Research Labs.

Engineering Symposium of Future Control of Resistance-Welding Machines, by C. E. Smith, Taylor-Winfield Corp.

A Study of Projection Welding, by W. F. Hess & Wylie J. Childs, Rensselaer Polytechnic Institute.

CUTTING

Powder Cutting as a Production Tool, by D. H. Fleming, Jr., Linde Air Products Co.

The Theory of Oxyarc Cutting, Preheating Effect, Functions of Coating, Functions of Core, Stack Cutting, Non-Ferrous Cutting, by H. C. Campbell, Arcos Corp.

Flux Cutting Alloy Steels, by G. E. Bellew, Air Reduction Sales Co.

Oxyacetylene Production Cutting in Steel Mills, by A. H. Yoch & W. Begerow, Air Reduction Sales Co.

SHIP STRUCTURES RESEARCH

The Work of the Ship Structures Committee, by Rear-Admiral Ellis Reed-Hill, Chairman Committee, U. S. Coast Guard.

Cleavage Fracture of Ship Plates—Tests of Wide Notched Plates, by A. Boodberg, H. E. Davis, E. R. Parker & G. E. Troxell, University of California.

Cleavage Fracture of Ship Plates as Influenced by Size Effect, by W. M. Wilson, R. A. Hechtman & W. H. Bruckner, University of Illinois.

A Study of Internally-Notched Tensile Specimens for Evaluating the Toughness of Structural Steel, by H. R. Thomas & D. F. Windenburg, David Taylor Model Basin, USN.

Physical and Chemical Tests Including Impact Tests on Steels Removed from Fractured Ships, by Dr. G. Ellinger, U. S. Bureau of Standards.

Wednesday, October 22

Afternoon—2:00 P.M.

RESISTANCE WELDING

Fundamentals of Spot Welding of Steel Plate, by W. D'Orville Doty, Wylie J. Childs & W. F. Hess, Rensselaer Polytechnic Institute.

The Development and Application of Quality Control Techniques to Resistance Welding Production, by O. C. Frederick, General Electric Co.

Shunt Circuit Impedance in Spot Welding, by Robert Blair, Taylor-Winfield Corp.

NONFERROUS

Arc Welding Copper and Copper-Base Alloys, by F. E. Garriott, Ampco Metal, Inc.

Static Strength Tests of Fillet Welds on Aluminum Alloy 61S-T Plate, by R. L. Moore, Aluminum Co. of America.

SHIP STRUCTURES RESEARCH

Tests of Various Designs of Welded Hatch Corners for Ships, by E. Paul DeGarmo, University of California.

Correlation Investigations of Small Specimens with Wide Plate Tests, by Maxwell Gensamer, E. P. Klyer & S. C. Wagner, Penn State College.

A Method of Evaluating Transition from Shear to Cleavage Failure in Ship Plate and Its Correlation with Large Scale Plate Tests, by Noah A. Kahn & Emil A. Imbembo, New York Naval Shipyard.

Thursday, October 23

Morning—9:30 A.M.

LOW ALLOY STEELS

Factors Affecting Weldability of Carbon and Alloy Steels, by C. E. Jackson, K. H. Koopman & C. M. Offenhauer, Union Carbide & Carbon Research Labs.

Submerged Melt Welding of Steels of High Hardenability, by E. A. Clapp & E. L. Frost, Union Carbide & Carbon Research Labs.

Marco-Etching and Photomacrography of Ferritic and Austenitic Welded Joints in Low-Alloy Steel, by O. O. Miller & E. G. Houston, United States Steel Corp.

MISCELLANEOUS

Design of Arc-Welded Steel and Its Relation to Cost, and Motion Picture, by R. H. Davies, Lincoln Electric Co.

High-Speed Technicolor Motion Picture of Welding Arc, by G. E. Claussen, Reid-Avery Co.

Stud Welding, by R. C. Singleton, Nelson Sales Corp.

STRUCTURAL

Design and Construction of Welded Research Laboratory Building, by LaMotte Grover, Air Reduction Sales Co.

Shape-Welding by the Submerged Melt Process, by J. A. Kratz, Linde Air Products Co.

Investigation on the Effect of Paint on the Quality of Fusion Welds in Structural Steel, by R. W. Bennett, R. D. Williams & C. B. Voldrich, Battelle Memorial Institute.

Friday, October 24

Morning—9:30 A.M.

INERT GAS WELDING

Mechanized Inert-Gas-Shielded Arc Welding, by H. R. Herbst, Linde Air Products Co.

New Applications of Inert Arc Welding, by R. W. Tuthill, General Electric Co.

AMERICAN INDUSTRIAL RADIUM & X-RAY SOCIETY: Technical Program

Beginning Wednesday, the American Industrial Radium & X-Ray Society will hold their 3-day annual meeting at the Hotel Morrison. Fifteen papers will be presented at five sessions. The annual meeting and Lester Lecture will be Thursday afternoon. At the annual meeting the Society will change its name to the Society for Non-Destructive Testing.

Wednesday, October 22

Morning—9:30 A.M.

Profitable Mass X-Ray Inspection, by Justin G. Schneeman.

Skin Thickness in Bronze Castings as Shown by X-Ray of Thin Sections, by Carlton G. Lutts.

Polaroid Vectograph Technique Applied to Stereo-Microradiography, by Don H. McCutcheon & Merle F. Valede.

Wednesday, October 22

Afternoon—2:00 P.M.

Development of a Universal Exposure Slide Rule for Radium Radiography, by Jay Bland & N. A. Kahn.

The Use of Isotopes in Industrial Radiography, by Gerald N. Tenney.

A Metallurgical Problem Solved by X-Ray Diffraction, by Herbert Mermagen.

Thursday, October 23

Morning—9:30 A.M.

Analysis of Industrial Problems—Coordinated Spectroscopy and X-Ray Diffraction, by W. J. Poehlman & W. A. Kluck.

Automatic Processing of X-Ray Film, by F. Glenn Hamilton & Robert Sardeson.

Influence of Field Size on Contrast and Exposure in Industrial Radiography, by E. Dale Trout & A. L. Pace.

Thursday, October 23

Afternoon—2:00 P.M.

LESTER LECTURE

Non-Destructive Testing in the Design, Manufacture and Evaluation of Naval Ordnance, the 1947 Lester Lecture, by Leslie W. Ball.

ANNUAL MEETING

Friday, October 24

Morning—9:30 A.M.

Application of Radiography in Die Casting, by R. W. Dively.

Electronic Applications to Non-Destructive Testing, by Arthur E. Johnson.

Deflected Beam Technique in Million Volt Radiography, by Harold Wagner & Don H. McCutcheon.

Friday, October 24

Afternoon—2:00 P.M.

The Application of the 20-Million Volt Betatron to Industrial Radiography, by Jack T. Wilson.

Van de Graaff 2-Million Volt X-Ray Precision Radiographic Technique, by A. E. Burrill.

The Use of Filters in Million Volt Radiography, by G. M. Corney.

List of Exhibitors

At least 300 suppliers of materials, equipment and services will show their latest developments and regular line of products in the International Amphitheatre daily from Saturday through the following Friday. Published here is the list of exhibitors, complete, with the exception of those companies to whom space was assigned late.

	Space No.
Acme Aluminum Foundry Co.	2301
Acme Manufacturing Co.	2423
Acme Steel Co.	2424
Advance Aluminum Castings Corp.	2210
Air Reduction Sales Co.	330
Ajax Electric Co., Inc.	1054
Ajax Electrothermic Corp.	1151
Ajax Engineering Corp.	1051
Allegheny Ludlum Steel Corp.	216
Allison Co.	1110
Alloy Casting Corp.	246
Alloy Rods Co.	1809, 1813
Alox Corp.	141
Aluminum Co. of America	630
Alvey Ferguson Co.	1037
Ameraco Industrial Specialties	2425
American Brake Shoe Co.	342
American Brass Co.	939
American Chain & Cable Co.	1110
American Cyanamid Co.	850
American Emblem Co., Inc.	1521
American Gas Association	617, 620, 720, 818
American Metal Market	1915
American Wheelabrator Co.	910
Ampco Metal, Inc.	110
Applied Research Lab.	2516
Arcos Corp.	1515
Arwood Precision Casting Corp. (J. R. Woods Prod. Co.)	932
Aurora Metal Co.	2009
Automatic Bending Co.	1815
Austenal Laboratories, Inc.	149
Automotive Industries	2808
Automatic Transportation Co.	740
Baldwin Locomotive Works	1042
Bastian Blessing Co.	108
Bausch & Lomb Optical Co.	1422
Behr-Manning Co.	1711
Bell & Gossett Co.	421
Blakeslee & Co., G. S.	1338
Bradley Washfountain Co.	2707
Braeburn Alloy Steel Corp.	1032
Brickseal Refractory Co.	1917
Bridgeport Brass Co.	1251
Bristol Co.	339
Brown Instrument Co.	1138
Budd Co., Induction Heating Div.	935
Buehler, Ltd.	1615
Burdett Manufacturing Co.	1426
Cambridge Wire Cloth Co.	2640
Carboloy Co., Inc.	1142
Central Scientific Co.	1509
Champion Rivet Co.	2708
Chayes Dental Inst. Corp.	2416
Cherry Rivet Co.	1223
Chicago Steel Foundry Co.	310
Cincinnati Milling Machine Co.	2702
Cities Service Oil Cos.	230
Clark Instrument, Inc.	1816
Cleveland Crane & Engr. Co.	1210
Climax Molybdenum Co.	2102
Clinton Machine Co., Inc.	2725
Columbia Tool Steel Co.	1119
Commonwealth Edison Co.	2002
Continental Ind. Engrs., Inc.	521
Crown Rheostat & Supply Co.	224
Crucible Steel Co. of America	1131
Cullen-Friestedt Co.	A-1820
Dearborn Industrial Mfg. Co.	2005
Delaware Tool Steel Corp.	1026
Detrex Corp.	2216
Detroit Electric Furnace Co.	2916
Detroit Testing Machine Co.	1610
Dietert Co., Harry W.	1019
Diamond Machine Tool Co.	225
Dillon & Co., Inc., W. C.	943
Diversey Corp.	221
Division Lead Co.	A-2635
DoAll Midwest Co.	2315
Dreis & Krump Mfg. Co.	1246
Driver Co., Wilbur B.	235
Eastman Kodak Co.	1226
Ecco Hi Frequency Corp.	921
Electric Furnace Co.	833
Electro Refractories & Alloys	240
Eutectic Welding Alloys Corp.	548
Executone, Inc.	2815
Fahralloy Co.	2408
Fansteel Metallurgical Corp.	2115
Fast Feed Machine Corp. of Ohio	1906
Ferro Bronze Corp.	1822
Finnell System, Inc.	2924
Foxboro Co.	926
Frontier Bronze Corp.	1115
Gaertner Scientific Corp.	1517
General Alloys Co.	640
General Electric Co.	1128
Gerity-Mich. Die Casting Co.	1606
Gerrard & Co., A. J.	2006
Globe Imperial Co.	2110
Goldsmith Bros. Smelting & Ref.	2923
Goodrich Co., B. F.	1315
Gordon, Claud S.	525
Gordon Electronics	1250
Green Electric Co., W.	349
Greenlee Foundry Co.	2830
Grobet File Co. of America	2724
H & H Research Co.	115
Hammond Machinery Builders	142
Handy & Harman	150
Hardy, Inc., Charles	1618
Harnischfeger Corp.	1202
Harper Co., H. M.	1910
Hauck Mfg. Co.	1002
Hevi-Duty Electric Co.	135
Hitchcock Publishing Co.	2723
Hobart Bros. Co.	906
Holcroft & Co.	1031
Holden Co., A. F.	550

	Space No.
Honan-Crane Corp.	2331
Houghton & Co., E. F.	948
Huppert Co., K. H.	2731
Hydraulic Press Mfg. Co.	522
Illinois Testing Lab., Inc.	920
Industrial Bulletin	1503
Industrial Publishing Co.	639
Industrial Tape Corp.	942
International Nickel Co.	637
Iron Age	245
Jackson Products	1909
Janney Cylinder Co.	154
Jones & Laughlin Steel Corp.	442
Jones Co., G. Walker	2823
Joslyn Mfg. & Supply Co.	236
Kelley-Koett Mfg. Co.	1515
Kennametal, Inc.	2613
Kerr Mfg. Co.	2625
Kewaunee Mfg. Co.	1709
King, Andrew	1232
Kloster Steel Corp.	1238
Knu-Vise, Inc.	2015
Koch Sons, Inc., Geo.	2816
Krieg Co., Charles W.	1529
Krouse Testing Machine Co.	526
Kux Machine Co.	1209
LaSalle Steel Co.	2508
Lead Industries Association	1602
Leeds & Northrup Co.	1101
Lepel High Frequency Lab., Inc.	929
Lester Phoenix, Inc.	1316
L'Hommedieu & Sons, Chas. F.	250
Lincoln Electric Co.	734
Lindberg Engineering Co.	726
Lindberg Steel Testing Co.	1038
Liquid Carbonic Corp.	2417
Los Angeles Chamber of Commerce	2725
McKay Co.	2636
Machinery (Industrial Press)	444
Machinery & Welder Corp.	1137
Magnaflux Corp.	541
Magnesium Association	341
Magnetic Analysis Corp.	1308
Mallory & Co., P. R.	2701
Manderscheid Co.	146
Manhattan Rubber Div.	1215
Martindale Electric Co.	1516
Materials & Methods	1337
Metal Finishing Service	2530
Metal Industries Catalog	1337
Metal Industry Publishing Co.	2715
Metal & Thermit Corp.	316
Metal Working Equipment (Sutton Publishing Co.)	2418
Metals and Alloys	1337
Metals & Controls Corp.	1817
Metallizing Co. of America	2336
Michiana Products Corp.	2720
Mid States Equipment Corp.	2536
Midvale Co.	329
Midwestern Sales Corp.	1905
Milburn Co.	2717
Miller Motor Co.	2010
Milne Co., A.	2106
Mine Safety Appliances Co.	1616
Miskella Infra-Red Co.	2415
Modern Metals	2635
Molybdenum Corp. of America	733
Monarch Steel Co.	1150
National Cylinder Gas Co.	107
National Diamond Hone & Wheel	1814
National Engineering Co.	2307
Nat'l Industrial Publishing Co.	2829
National Industrial Launderers & Cleaners Assn.	2524
National Research Corp.	2018
Nat'l Time & Signal Corp.	2435
Nelson Sales Corp.	322
New Jersey Zinc Co.	1706
Ohio Carbon Co.	2430
Ohio Crankshaft Co., Tocco Div.	644
Ohio Seamless Tube Co.	1321
Ohio Steel Foundry Co.	151
Olson Testing Machine Co., T.	345
Osborn Mfg. Co.	2407
Packer Machine Co.	1928
Pangborn Corp.	409
Page Steel & Wire Div.	1219
Park Chemical Co.	634
Parker-Kalon Corp.	2404
Penton Publishing Co.	209
Permanente Products Co.	304
Peters-Dalton, Inc.	1828
Peterson Welding Laboratories	1818
Phillips Mfg. Co.	1322
Picker X-Ray Corp.	426
Pines Engineering Co., Inc.	306
Porter-Cable Machine Co.	1409
Powder Weld Process Co.	1630
Precision Scientific Co.	315
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MATERIALS & METHODS Engineering File Facts

NUMBER 149
October, 1947

MATERIALS: Stainless Steel
METHODS: . . . Forging

Forging Stainless Steel

Forging is a desirable method of fabrication for stainless steels for many purposes, such as forming of turbine blades or cutlery. All the grades of stainless steel are forgeable, though ease of forging varies among the types. Even the free machining grades, to which sulfur or selenium has been added, do not show any pronounced hot shortness. All grades of stainless steel possess high temperature strength, and deform with some difficulty even at red heat. It is good practice to finish forge these steels with light blows as the steel cools to the lower temperatures in the forging range, so as to avoid tearing the steel.

The lower thermal conductivity of the stainless steels makes it important to allow for ample soaking time before beginning the forging operation. This is especially true of the higher-carbon grades. Preheating may be useful to insure through heating of the work if the billet is thick.

Austenitic Types: These steels are somewhat easier to forge than most of the other grades. The higher alloy compositions should be finished at a slightly higher temperature than the other types.

Martensitic Types: Steels of this classification are air hardening, and precautions should be taken to avoid embrittlement. The higher-carbon grades should be cooled slowly to avoid hardening; lime may be helpful for this purpose. Preheating is sometimes used when thorough penetration of the heat is difficult to obtain otherwise.

Ferritic Types: Nonhardenable by heat treatment, forging of these steels presents no special problem. They are subject to grain growth upon prolonged exposure to high temperatures, but the time of exposure involved in forging is not sufficient to cause any appreciable change.

In preparing stainless steels for forging, it is good practice to heat rather slowly until the metal reaches a temperature of about 1400 F. The rate of heating may then be increased until the forging temperature is reached. For the high-carbon grades this can be accomplished satisfactorily by using a preheat furnace, while the low-carbon types will not require more than ordinary careful handling in the furnace. Forging at a temperature below the top of the forging range will make the operation more difficult, while prolonging the forging below the recommended lower limit carries with it the danger of cold shuts and of setting up stresses in the work.

A range of forging temperatures for the types now given as standard by the American Iron & Steel Institute is listed below.

Type No.	Composition			Others	Forging Range
	Carbon	Chromium	Nickel		
Austenitic Stainless Steels					
301	Over 0.08	16.0-18.0	6.0- 8.0	—	2200-1700 F
302	Over 0.08	17.0-19.0	8.0-10.0	—	2200-1700
303	0.15 max.	17.0-19.0	8.0-10.0	P, S, Se 0.07 min., Zr, Mo 0.60 max.	2250-1750
304	0.08 max.	18.0-20.0	8.0-11.0	—	2200-1700
305	0.12 max.	17.0-19.0	10.0-13.0	—	2200-1500
308	0.08 max.	19.0-21.0	10.0-12.0	—	2200-1700
309	0.20 max.	22.0-24.0	12.0-15.0	—	2150-1850
310	0.25 max.	24.0-26.0	19.0-22.0	—	2150-1850
314	0.25 max.	23.0-26.0	19.0-22.0	—	2000-1700
316	0.10 max.	16.0-18.0	10.0-14.0	Mo 2.0-3.0	2100-1700
317	0.10 max.	18.0-20.0	11.0-14.0	Mo 3.0-4.0	2200-1750
321	0.08 max.	17.0-19.0	8.0-11.0	Ti added	2200-1700
347	0.08 max.	17.0-19.0	9.0-12.0	Cb added	2200-1700
Martensitic Group					
403	0.15 max.	11.5-13.0	—	—	2100-1600
405	0.08 max.	11.5-13.5	—	Al 0.10-0.30	2050-1800
406	0.15 max.	12.0-14.0	—	Al 3.5-4.5	2050-1800
410	0.15 max.	11.5-13.0	—	—	2100-1600
414	0.15 max.	11.5-13.5	1.25-2.5	—	2150-1400
416	0.15 max.	12.0-14.0	—	P, S, Se 0.07 min., Zr, Mo 0.60 max.	2200-1600
420	Over 0.15	12.0-14.0	—	—	2000-1750
431	0.20 max.	15.0-17.0	1.25-2.5	—	2150-1400
440A	0.60-0.75	16.0-18.0	—	Mo 0.75 max.	2100-1750
440B	0.75-0.95	16.0-18.0	—	Mo 0.75 max.	2100-1750
440C	0.95-1.20	16.0-18.0	—	Mo 0.75 max.	2000-1750
501	Over 0.10	4.0- 6.0	—	—	2100-1500
502	0.10 max.	4.0- 6.0	—	—	2100-1500
Ferritic Group					
430	0.12 max.	14.0-18.0	—	—	1950-1400
430F	0.12 max.	14.0-18.0	—	P, S, Se 0.07 min., Zr, Mo 0.60 max.	1950-1500
446	0.35 max.	23.0-27.0	—	—	2100-1600

Compiled by Kenneth Rose, Engineering Editor

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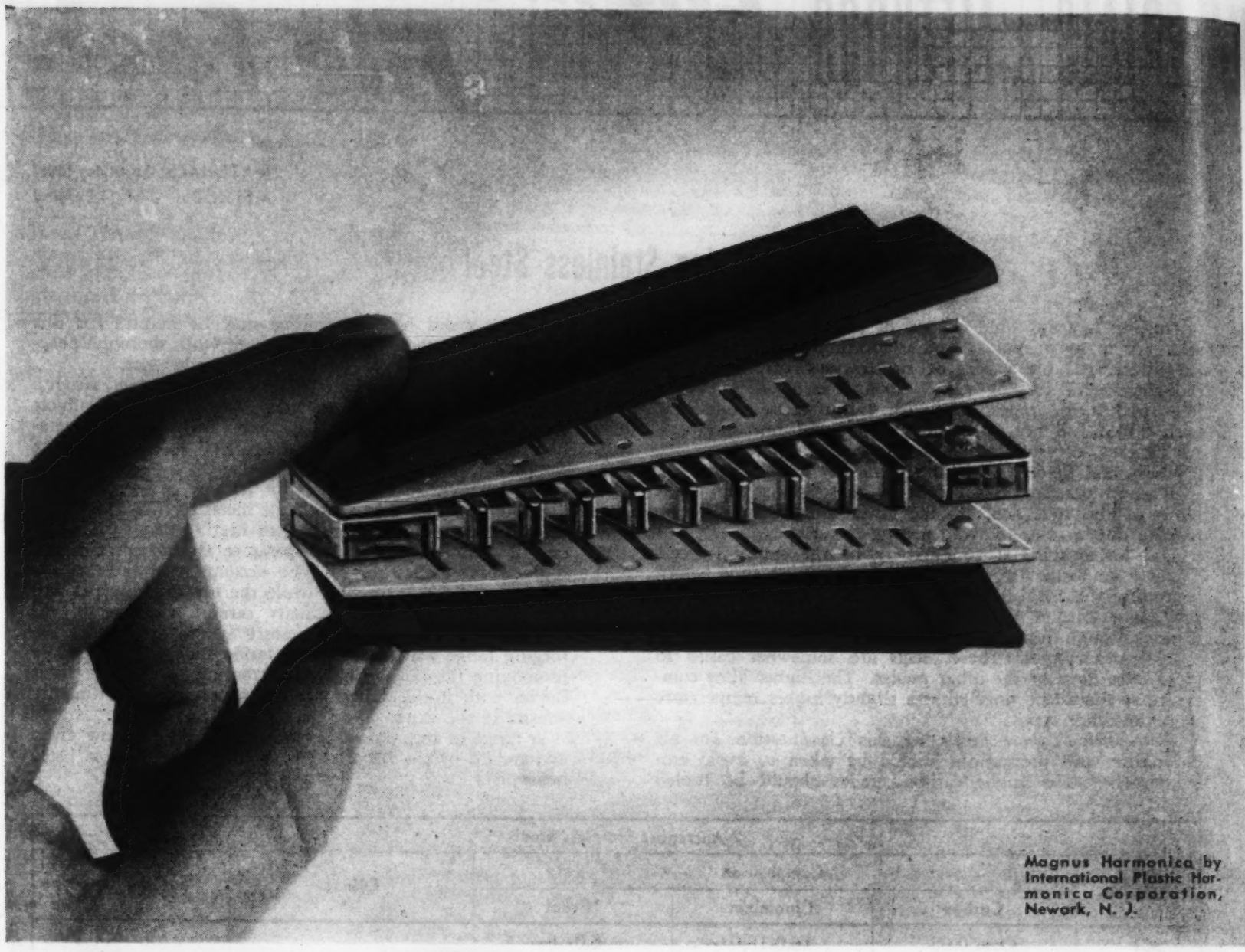

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MATERIALS & METHODS **Engineering File Facts**

NUMBER 150
October, 1947

MATERIALS: Lead Alloys

Lead Alloys for Industry

This page supplements Engineering File Facts Nos. 58—"Low Melting Alloys;" 93—"Low Tin Solders;" 99—"Lead Base Solders and Babbitts;" and 105—"Lead (Specifications and Properties)." Because some of these alloys have been considered in more detail in earlier numbers, they have been summarized only briefly here.

Lead-Base Bearing Alloys

ASTM Alloy Grade No.	Composition, Per Cent					Ultimate Strength* Psi.		Brinell Hardness		Pouring Temp. F	Corrosion	Uses
	Sn	Sb	Pb	Cu	As	68 F	212 F	68 F	212 F			
6	20	15	63.5	1.75 max.	0.15	14,550	8,050	21.0	10.5	655	Resistant to corrosion from organic acids	Good casting properties. Moderate service conditions.
7[1]	10	15	75	0.50 max.	0.60	15,650	6,150	22.5	10.5	640	Resistant to corrosion from organic acids	General purpose.
8	5	15	80	0.50 max.	0.20	15,600	6,150	20.0	9.5	645	Resistant to corrosion from organic acids	General purpose.
10	2	15	83	0.50 max.	0.20	15,450	5,750	17.5	9.0	630	Resistant to corrosion from organic acids	General purpose.
11	—	15	85	0.50 max.	0.25	12,800	5,100	15.0	7.0	630	Moderate resistance to corrosion from organic acids	General purpose.
12	—	10	90	0.50 max.	0.25	12,900	5,100	14.5	6.5	625	Moderate resistance to corrosion from organic acids	Slow moving machinery.
15[2]	1	15-17	82.5-80.5	0.60 max.	1.40	—	—	21.0	13.0	662	Should not be subjected to action of break-in oils containing oleic or similar acid	Automotive engine bearings.
19	5	9	86	0.50 max.	0.20	15,600	6,100	17.7	8.0	620	Resistant to corrosion from organic acids	Railroad car and tender bearings.

* *Ultimate strength values were taken as the unit load necessary to produce a deformation of 25% of the length of the specimen*

[1] *Compares with S.A.E. 14*
[2] *Compares with S.A.E. 15*

Solders

Composition, Per Cent				Liquidus C	Solidus C	Strength of Copper Joint 0.005-in. Thick in Psi.	Uses
Sn	Pb	Sb	Ag				
1	98	—	1.5	308	304	4,420	Electrical, high temperatures.
5	95	—	—	313	291	6,380	Coating, high temperature jointing.
15	85	—	—	285	225	5,640	Automobile body solder. Terne plating.
25	75	—	—	266	183	5,795	General low grade. Terne plating. Automobile body solder.
33	67	—	—	252	183	6,450	Low grade wiping solder.
40	60	—	—	238	183	8,280	Wiping solder for joints in lead pipe and cable sheathing. Automobile radiator cores and heating units.
37.5	60	2.5	—	224	186	8,250	Wiping solder for joints in lead pipe and cable sheathing.
50	50	—	—	216	183	7,580	Most popular general purpose solder.
63	37	—	—	183	183	8,000	Fine solder. General purpose.

Antimonial Lead

Sb %	Density	*Ten. Str., Psi.	Elong., %	*Hardness, Brinell No.	Liquidus F	Solidus F	Uses
1	11.26	3,400	—	7.0	612	603	Packaging foil, bullet cores, cable sheathing, collapsible tubes.
4	11.03	5,660	22	10.1	578	485	Shot, battery lugs.
7	10.81	7,180	21	12.5	539	485	Grid metal, architectural lead work.
10	10.59	7,670	15	14.6	505	485	Grid metal, C. T. metal, slush casting.
13	10.38	7,280	10	15.2	492	485	Shrapnel, C. T. metal, slush casting.
15	10.23	6,800	8	—	—	—	—

* *Tests made with cast pieces*

Type Metal

Composition, Per Cent			Liquidus F	Hardness, Brinell No.	Uses
Pb	Sn	Sb			
94	3	3	570	14	Electrotype
84.5	4	11.5	475	22	Linotype
81	5	14	493	23	Stereotype
82	6	12	491	23	Government alloy
76.5	7	16.5	527	26	Monotype
62	14	24	605	32	Foundry type

Tellurium Lead

Composition	Liquidus F	Tensile Strength	Remarks
Chemical lead with 0.035 to 0.05 tellurium	617	3,000	Good corrosion resistance, particularly at high temperatures. Withstands vibration and mechanical strain. Has capacity to strengthen under strain.

Compiled by the Lead Industries Association

MATERIALS & METHODS

DIGEST

A selective condensation of articles — presenting new developments and ideas in materials and their processing — from foreign journals and domestic publications of specialized circulation.

Edited by H. R. CLAUSER

Electrolytic Polishing

Condensed from "Metal Industry"

Producing a high degree of polish on stainless steel by mechanical methods is neither easy nor quick. The mechanical polishing of nickel silver is not so difficult but the stressed, cold worked layer produced by the mechanical working may be less corrosion resistant. Moreover, particles of the abrasive compound may be embedded in the surface.

Electrolytic polishing tests were carried out on stainless steel and nickel silver teaspoons; the nickel content of the latter varied from 12 to 22%. The electrolytes used were: phosphoric acid and water, phosphoric acid, sulfuric acid and water; perchloric acid and acetic acid; citric acid, sulfuric acid and water. Etched and pitted surfaces were very evident with these solutions but the first was most promising. When the phosphoric acid was progressively replaced by glycerine, the reflectivity of the polished surface increased but the area which could be polished was reduced. The best surface finish was obtained with an electrolyte containing 37% orthophosphoric acid, 56% glycerine and 7% water.

With the orthophosphoric acid—glycerine—water electrolyte, a good polish was obtained on the stainless steel at 212 to 250 F, while 120 to 160 F gave the best results for the nickel silver. A wide range of current densities could be used with the stainless steel but the optimum results were obtained at 5 to 10 amp. per sq. in. A current density of one amp. per sq. in. was most satisfactory for the nickel silver. The time required at a given current density and temperature depends on the original surface finish of the article. Five to ten min. was sufficiently long to give the desired surface finish on "barrelled" stainless steel spoons.

Tests to determine the effect of the original surface-finish on the final polish of stainless steel showed that a finely ground surface gives the smoothest surface and highest degree of luster, while a coarse grinding results in an unsatisfactory finish.

At the present time electrolytic polishing does not entirely replace hand-polishing methods, but rather is a supplementory process which can be used in place of some of the hand operations. (H. Evans & E. H. Lloyd. *Metal Industry,* Vol. 71, July 4, 1947, pp. 10-12.)

Forging High Temperature Alloys

Condensed from a Paper of the American Society of Mechanical Engineers

Results of an investigation on turbine wheel blanks and completely bucketed wheels showed that on gas turbine forgings the most important consideration for securing good turbine wheels is high ductility. Adequate control over grain flow within the forging is essential in obtaining high over-all ductility in the plane of maximum stress, and the proper use of solution treatment is an additional step in this direction. Also, conscientious use of the proper combination of inspection procedures is an extremely important factor.

It was found that the center of the rotating wheel is the critical area and not the rim, and that the quality of the center area is much more difficult to control in a large forging than in a small one. From this it was concluded that the ductility was the most important factor contributing to high and consistent bursting speeds. With good center ductility the harmful effect of minor discontinuities or mechanical defects was minimized.

Since grain flow and grain refinements are so important in ductility, investigations were made into each method of manufacturing the various blanks tested and these methods appraised. It was found that those made by the "center reversal process" (billet stage is eliminated by press forging the preformed ingot with several sets of contour dies, molding the ingot into a wheel blank by alternate kneading of the center and rim of the wheel blank) were most satisfactory because the kneading formed the flow lines into the positions most advantageous for operating conditions.

The solution treatment found effective consisted of heating the metal to a temperature sufficiently high to dissolve the carbides and intermetallic compounds in an austenitic solid solution. Temperatures ranged from 2100 to 2500 F, and forgings were held at that temperature for at least an hour to allow time for the solution to take place. In addition to increasing ductility, solution treatment also tends to equalize the variable conditions due to poor control over the finishing temperature during hot work.

It was also indicated that when solution treatment is used in conjunction with certain beneficial factors of good processing, the bursting speeds were consistently high. Presence of these other factors is necessary for good bursting speed, and not solution treatment alone. (L. B. Fonda, Paper, *Am. Soc. Mech. Engrs.,* June 1947 meeting.)

Hardening Power of Quenching Media

Condensed from "Journal of the Iron & Steel Institute"

Some simple standard test would be useful for the comparison of the hardening powers of different quenching media. Although there is much to be said for the direct method of hardness measurement on actual quenched specimens, it is uncertain to what extent the results of an experiment on one size specimen of one particular steel are applicable to other steels and other sizes of specimens.

To investigate this matter, five quenching oils and hot and cold water were used, but most work was done with water and one of the oils. The comparisons were made purely on the basis of cooling rate and hardness produced in quenched steels. The other desirable attribute of a quenching medium, that it should not cause quench cracking, was neglected.

Cooling rates were determined at the center of a silver cylinder. No simple correlation was apparent with the cooling rates thus obtained and the hardnesses found in quenched cylinders of a high carbon chromium-molybdenum steel. It seems impossible to correlate accurately the hardness with the cooling time over a particular range of temperature for steels such as this one where the transformation temperature

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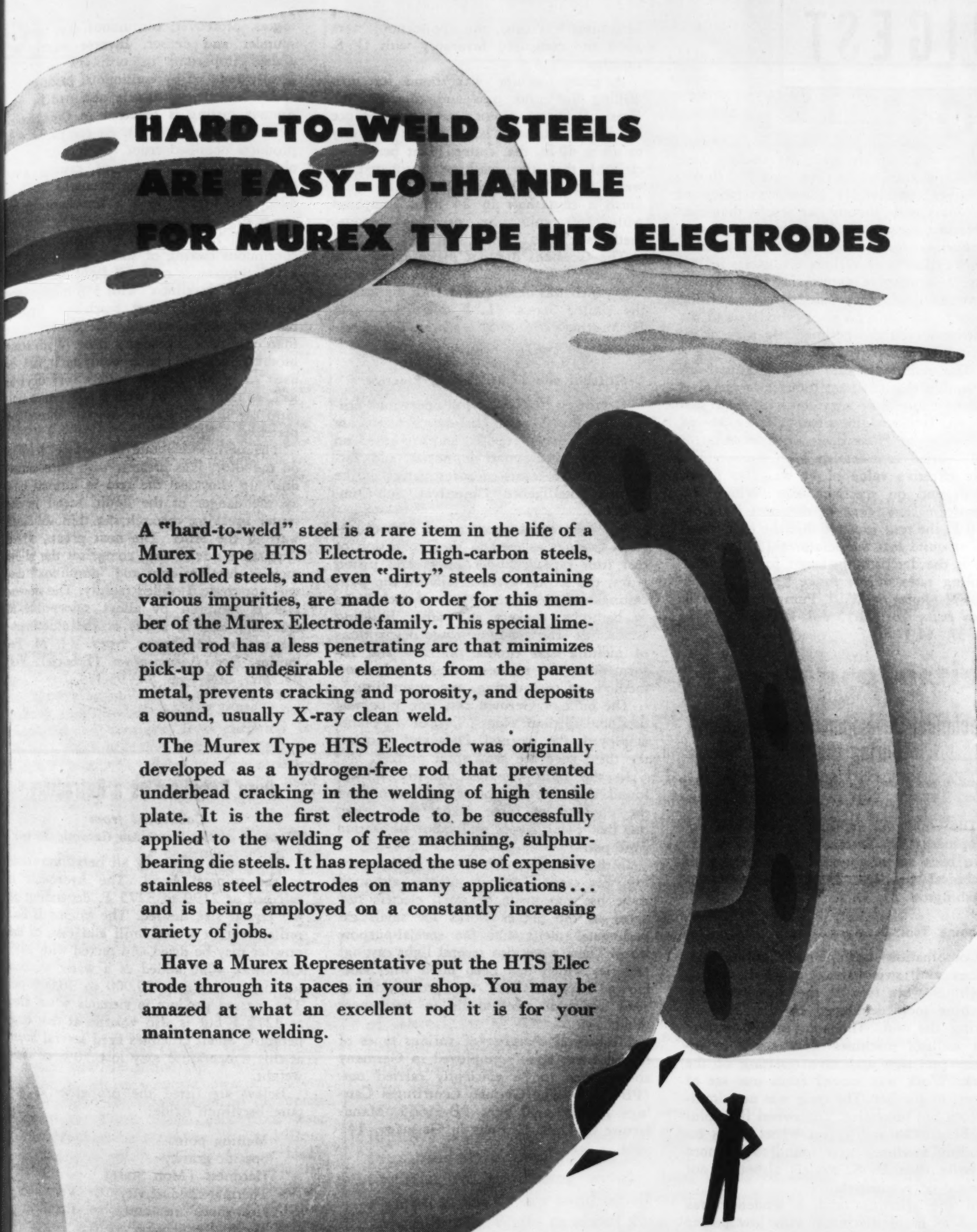

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varies considerably with the cooling rate. However, the cooling time from 930 to 480 F gives considerably better correlation of hardness with Jominy bar results than that obtained using the half temperature time.

Further tests were made with stainless steel cylinders of various diameters. In this case a qualitative agreement was obtained between predictions based on the cooling rates of the stainless steel cylinders and the hardnesses found experimentally in quenched cylinders of hardenable steels.

The results indicate that the usual assumption that the heat transfer factor H is constant should be regarded with some suspicion. Tests with the silver cylinder showed the value of H as determined experimentally varied considerably with temperature. The effective value of H was also found to depend on specimen size. Where the transformation range of the steel is below 930 F, the tests indicate that the heat transfer at quite low temperatures (570 to 390 F) is the determining factor for the center cooling rates in the range 930 to 480 F. (F. W. Jones & W. I. Pumphrey. *Iron & Steel Inst.*, (British), Vol. 156, May 1947, pp. 37 - 54.)

Technical Developments in Germany During the War

Condensed from Reports of the Office of Technical Services

The following reports on technical developments in Germany during the war have been recently issued by the Office of Technical Services, Dept. of Commerce, Washington 25, D. C.

Machine Tool Developments

Combination boring and milling machines and swivel head vertical milling machines were two of the very few new machine tools developed by the Germans during the war. The combination boring and milling machines were made to increase precision and save resetting of the work. Work was moved from one set of cutters to another. The cycle was not simultaneous but successive. The swivel live spindle headstocks and swivel wheel heads on grinding machines were found to be more versatile than U. S. models although not as rigid or productive.

In the grinding field, a tendency was noted to build machines with low power for a designated work swing. Ten-inch grinders, for example, would have range for full 10 in., but power, weight and grinding wheel capacity would be more nearly comparable to our 6-in. grinders.

Profile milling seemed to have been neglected in Germany until the war started. No independent development of automatic die sinking was found. Broaching was little used and not at all on cast iron. Where broaching was used, the applications were good and compared favorably with U. S. practice.

A giant machine was found for turn milling the crank pins and adjacent web faces of Diesel motor crankshafts. Since the crankshafts were large, it was necessary to use a 40-in. dia. cutter. Plant personnel claimed that the machine, estimated to weigh from 150,000 to 200,000 lb., could finish a crankshaft in 24 min. compared with 160 min. by previous turning methods.

The Germans did not make appreciable progress on high-speed negative rake milling, which was developed during the war in the United States. (L. E. Mehlhope & L. H. Martin. PB 63855, Machine Tool Practice in Germany, 78 pp.)

Centrifugal and Light Casting Practice

Details on manufacturing operations utilized by the German castings industry are contained in two reports, and are based on visits to 38 German foundries and factories by two teams of investigators of the British Intelligence Objectives Sub-Committee.

The first report is concerned with centrifugal castings as used in the production of cast iron pipe, cylinder liners and piston rings; the second gives details on the light castings industry manufacture of such items as bathtubs, cookers and other building accessories. The reports include descriptions of melting and cupola practices and information on tuyeres, sand equipment, methods of core drying, and enameling.

The bulk of German cast iron pipe was produced in three plants. Two of the plants employed the normal Delavand process; the third used the sand spun process.

In the light castings industry it was found that German plant equipment and the products of some plants were good, but that plant layout and labor utilization were poor.

In the foundries visited most of the melting was carried out in cupolas although some use was made of small electric furnaces in the bigger works for small experimental melts and for special-purpose irons. There were also several light castings factories which had been fitted with side-blown convertors for the production of steel and cast steel shells in permanent molds.

Mechanical charging of various types of furnaces was widely employed in Germany and seemed to be efficiently carried out. (PB-63856, The German Centrifugal Castings Industry, 90 pp.; PB-65665, Manufacture of Light Castings in Germany, 141 pp.)

Continuous Casting of Light Alloys

Condensed from "Revue de l'Aluminium"

The quality of continuous cast light alloy ingots and billets is much superior to that obtainable by the older methods. Continuous casting gives a fine homogeneous crystalline structure with no coarse crystals in the center, such as are often found in ordinary ingots. Moreover, continuous cast metal is sounder and denser. Inverse segregation, always important in ordinary ingots, is greatly reduced by continuous casting.

The excellent structure obtained by continuous casting is reflected in the properties of the final product. As compared with products obtained from ingots cast by the older processes, continuous casting gives elastic limits and tensile strengths 2845 to 4265 psi. higher with a simultaneous increase in elongation of 1 to 2%.

Of the various types of ingots used for continuous casting of slabs and billets, the most common is made of light alloy sheet, preferably "duralinox" with 3% magnesium, with the bottom part machined from a block of duraluminum. Generally, more than one ingot is cast at a time. With some modifications, the same equipment can be used to obtain hollow billets for tubes as well as slabs covered with a layer of aluminum for the fabrication of clad sheets and plates.

The permissible rate of casting depends on the alloy. It is greatest with pure aluminum. In this case the rate is limited only by the danger of the liquid metal in the center breaking through the thin solidified wall of the billet. The next group, which requires a slower rate, comprises the alloys such as duraluminum and "duralinox" that will not crack if cooled rapidly. The slowest rate is required by alloys susceptible to cracking, such as alloys of the aluminum-magnesium-zinc-copper types. (J. M. Peloutier. *Rev. l'Aluminium* (French), Vol 24, Mar. 1947, pp. 84 - 93.)

Pure Beryllium as a Refractory

Condensed from "Journal of the American Ceramic Society"

The source of nearly all beryllium oxide is the mineral beryl. The hydroxide is calcined at 2190 to 3275 F, depending on the crystal size desired. The calcine is ball milled wet in a steel mill and cast, or the powder may be dried and mixed with 14% Carbowax 4000 added as a water solution for dry pressing at 20,000 to 30,000 psi. The pressed product is vitreous when fired at 3275 F but is also volatile at that temperature. Small crucibles fired several hours at this temperature may lose 50% of their weight.

Below are listed the properties of the pure beryllium oxide:

Melting point	4550 F
Specific gravity	3.0
Hardness (Moh Scale)	9
Thermal conductivity	Very high
Heat-shock resistance	Excellent
Thermal expansion (mean up to 1400 C)	9.3×10^{-6} C

The dense beryllium oxide shows no dye absorption. Bodies of the material are translucent in thin sections, and the surface pure white and smooth. Beryllia is a stable refractory that finds use as a container in melting pure metal and alloys. When beryllia crucibles become commercially available, they should be excellent for experimental

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melts of slags and glass. Their high thermal conductivity, coupled with a high electrical resistivity, may adapt them for many special uses, such as for the production of thermoelectric power. Beryllia may also be of importance as a refractory for jet-propulsion engines.

As yet, little is known about the toxic effects of beryllium compounds, but evidence points to the fact that certain individuals are susceptible to beryllium oxide dust, which causes a lung condition. Extreme precautions should therefore be taken to have ample ventilation where dusty processes and fumes from these compounds are involved. (F. H. Norton. *J. Am. Ceramic Soc.*, Vol. 30, Aug. 1, 1947, pp. 242-245.)

Evaluating Creep of High Temperature Alloys

Condensed from "Journal of the Iron & Steel Institute"

The evaluation of creep of highly heat resistant alloys under sustained loads is quite intricate and complex. It is currently receiving much attention because of the problems it presents in the design of gas turbines, particularly stationary turbines which must have a much longer life than aircraft turbines.

The main problems which face engineers are: (1) the determination of the ultimate strength of materials which are to be in service at high temperatures for about 100,000 hr., and (2) the choice of a material in which the influence of notches and multi-dimensional stresses does not lead to excessive weakening.

In regard to the first problem, extrapolation over long periods is best done on the basis of stress rupture tests. Important conclusions as to structural stability may be drawn from several factors. The reduction of area and elongation are of great significance, as the true stress-contraction curves are essential for information on the notch sensitivity. Much useful data from tests with notched bars can be obtained from these curves which are S-shaped for many metals.

Room temperature tensile and impact properties of specimens broken in the stress rupture test are also important as well as changes in the metallographic structure and (for steels of the 18:8 type) magnetic saturation as a function of time. So far insufficient progress has been made to prescribe maximum or minimum values which can be regarded as admissible limits.

To investigate the influence of notches and multi-dimensional stresses, tests must be made on notched bars as well as on

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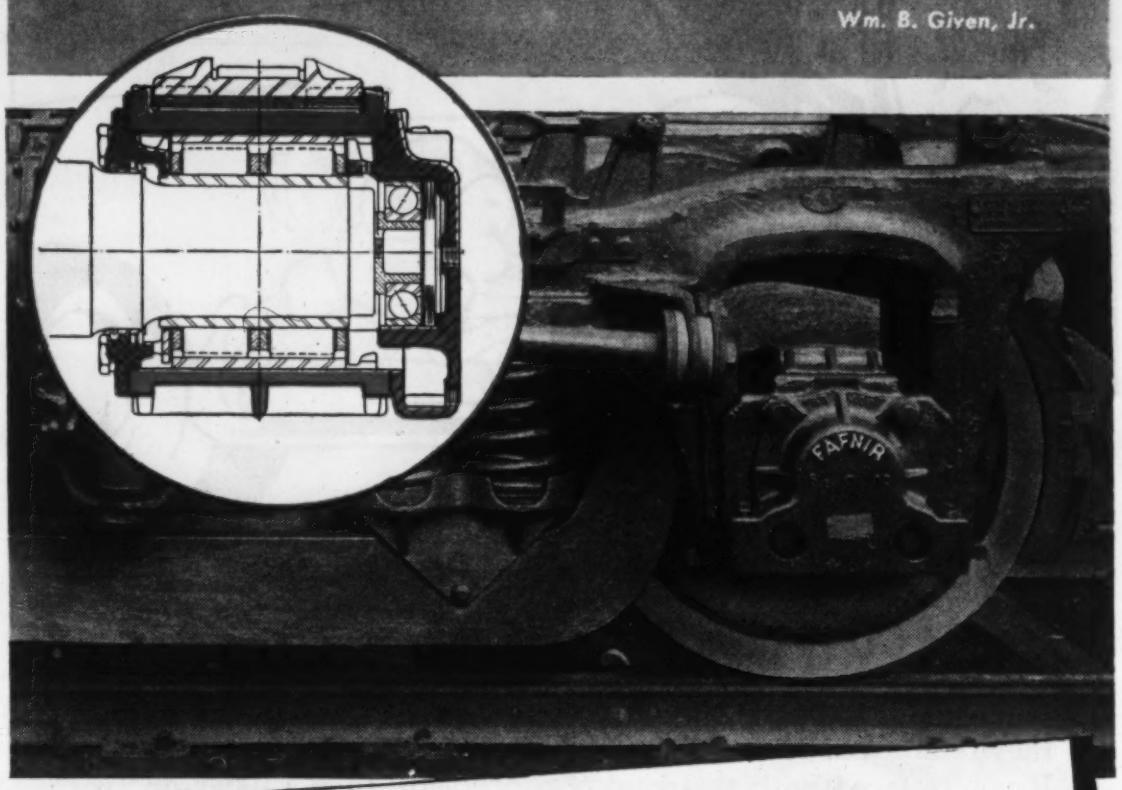

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whole machine parts. Without the S-shaped, true stress-contraction curve, it is impossible to draw any practical conclusions about the notch sensitivity. An important magnitude for gas turbine construction is that of extension; for stationary turbines a secondary creep extension of 0.1% in 100,000 hr should be permissible.

The view has been expressed that elongation measurements over short periods may be capable of providing information as to the limits of usefulness of a highly heat resistant steel, but other qualities, such as the tendency to brittleness and structural stability, which cannot be determined by such measurements are also essential for designing purposes. (W. Siegfried. *Iron & Steel Inst.* (British), Vol. 156, June 1947, pp. 189-207.)

"Electro-Erosion" Cutting of Metals

Condensed from "The Engineers' Digest"

A new unique method of metal cutting has been developed in Russia. The process cuts the metal by means of an electric spark discharge between the poles of a d.c. circuit. The spark discharge is produced by breaking the current between the poles, and this is accompanied by the removal of particles from the anode surface and their carryover to the cathode using an electrolytic fluid, waterglass.

The cutting is performed by touching a cutting disk, which is connected with the negative terminal of the circuit, to the work piece. Slight pressure on the disk gives rise to an electric discharge which produces the "electro-erosion." The cutting disk is mild carbon steel, 0.02 to 0.10 in. thick and 6 to 14 in. in dia. For cutting hard metals or steel the disk should be copper-plated. The disk is driven by a 2.5-kw. motor at spindle speed of 750 rpm.

In comparison tests with three other methods of cutting—the bandsaw, power hacksaw, and Heller saw—the electro-erosion process was found the only one suitable for hard metal. The process gives smooth surfaces with sharp even edges. Warping of the butt end does not exceed about 0.02 in. The width of cut does not exceed about 0.03 in. and makes it possible to cut off slices 0.078 in. thick.

In comparison to abrasive disk cutting, it is quicker and does not cause overheating and loss of hardness of the section affected. In cutting bar stock not exceeding 18.6 sq. in. in area, the output by the electro-erosion method is greater than that of power hacksaws, but somewhat more expensive.

The process is particularly useful for cutting carbides and hardened steels provided

DIGEST

the sectional area does not exceed 24.8 sq. in. and bar stock of steel and other metals provided the sectional area is not in excess of 7.8 sq. in. (T. P. Rekshinskaya. *Automobilnaya Promishlenost* (Russian), No. 5/6, 1946. pp. 12-15; as abstracted from *Engineers' Digest*, Vol. 4, July 1947, pp. 304-305.)

Sintered Iron and Steel for Structural Parts

Condensed from "Powder Metallurgy Bulletin"

The manufacture of shaped iron and steel parts from powders represents one of the youngest branches of powder metallurgy. There are three groups of sintered ferrous products which compete with products made by other methods.

In the first group, the porosity and plasticity of sintered materials permit applications which are impracticable with products by other methods. Uses of porous iron made by powder metallurgy methods include bearings, filters, diaphragms, and molds.

The sintered products of the second group are superior to competitive products because of their physical and chemical characteristics. A number of materials in this group are used in vacuum technique, instrument construction and electro industry. Typical examples are wires and sheets of purest iron, iron-nickel, iron-nickel-cobalt, iron-nickel-molybdenum and iron-molybdenum-copper.

The third group of sintered products represents finished parts which can be produced by powder metallurgy at lower costs than by other methods. Primarily, these include parts for small appliances and engines and hardware products. Typical parts are: gears, valve handles, perforated plates, keys, locks, and structural parts for machines and appliances.

The properties of sintered iron and steel vary widely with the processing technique. At low compacting pressures (14 tons per sq. in.) tensile strength of iron powder is around 11,000 psi., elongation is about 2%, density 5.50, and Vickers Hardness 32. At high pressures (42 tons per sq. in.) tensile strength is between 35,000 and 40,000 psi., elongation 14%, density 7.20, and Vickers Hardness 90.

Tensile strengths of sintered steels run from 50,000 to 100,000 psi., with increasing carbon content. Elongation is usually around 3.0 to 5.0%. The low elongations are characteristic of all sintered materials. (R. Kieffer, F. Benesovsky & H. J. Bartels. *Powder Met. Bulletin*, Vol. 2, May 1947, pp. 54-69.)

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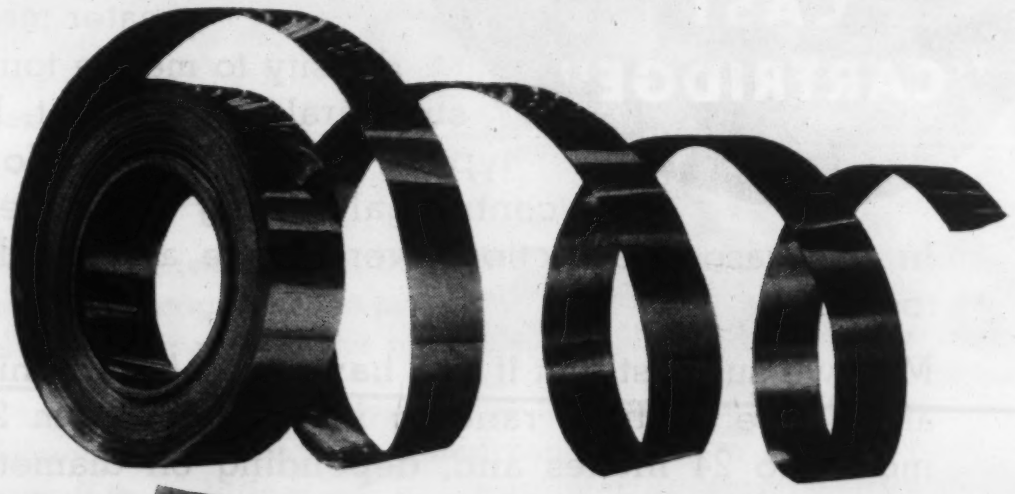

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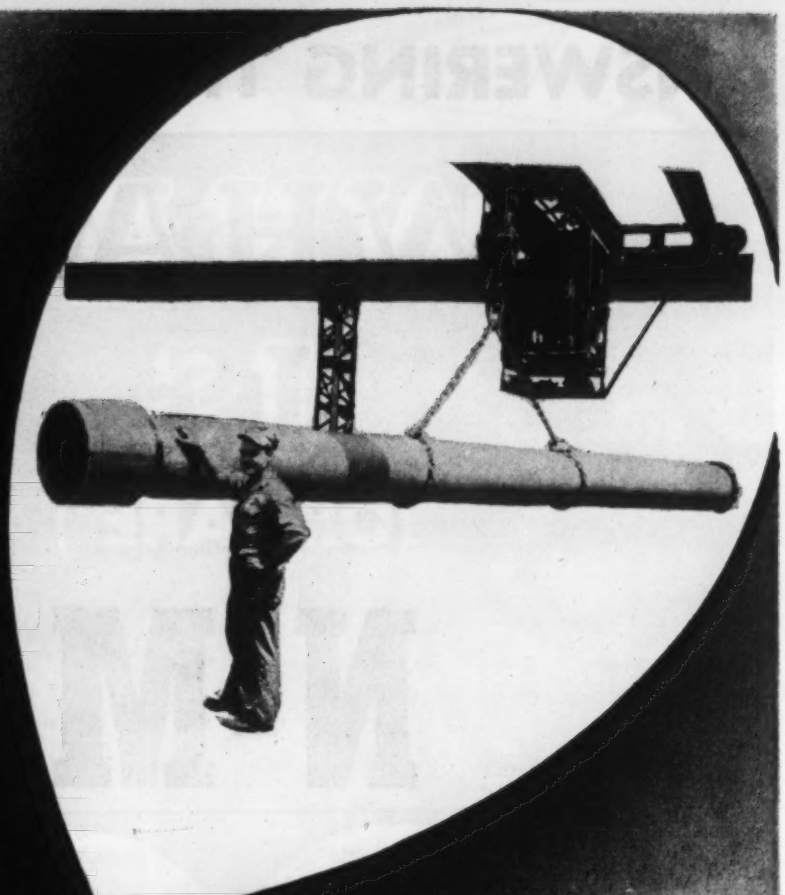

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Failures in Welded Steel Merchant Vessels

Condensed from the Report of the Board of Investigation on Welded Steel Merchant Vessels

Early in the war, a number of welded merchant vessels developed fractures, some of which resulted in the loss of the ship. The fractures in many cases came with explosive suddenness and showed a brittleness which was not ordinarily associated with the behavior of a normally ductile material such as ship steel.

This final report of the Board of Investigation thoroughly analyzes the fractures and sets down a number of very important conclusions as to the nature and cause of the fractures. The most important of these conclusions are:

1. The fractures were caused by notches and by steel which was notch sensitive at operating temperatures.

2. More fractures started at notches occasioned by design than at notches resulting from defective workmanship. Although the relative contribution of poor workmanship was less, there were important cases where workmanship was the sole cause. The starting point of the fractures in all cases was at a definite geometrical discontinuity.

3. Locked-in stresses did not contribute materially to the failures.

4. Existing specifications are not sufficiently selective to exclude steel which is notch sensitive at ship operating temperatures.

The results of the investigation have vindicated the all-welded ship. With proper detail design, high quality workmanship, and a steel which has low notch sensitivity at operating temperatures, a satisfactory all-welded ship structure may be obtained. (Final Report of a Board of Investigation convened by order of the Secretary of the Navy.)

Hardness Testing at Elevated Temperatures

Condensed from "Metallurgia"

Although the determination of hot hardness would appear to be relatively simple, much confusion has arisen in the past due to the lack of standardized testing techniques. Very often published data are not strictly comparable. To obtain strictly comparable results, care must be taken to standardize the conditions of testing throughout and particularly the heating rate and time at temperature of the material being tested.

The introduction of the sintered carbide

ball has greatly increased the scope of static hot hardness, removing many of the objections associated with the ordinary hardened steel indentors. Since these balls retain their hardness at comparatively high temperatures, much more accurate results can be obtained at these temperatures.

Impact hardness testing has been used extensively by the Germans. It overcomes many of the difficulties associated with static hardness tests at very high temperatures, such as scaling, deformation and tempering of the ball and chilling of the test piece by the ball. In static tests consideration must be given to the creep of the test piece under load; the impact test overcomes these difficulties to some extent.

It would seem that for most work the static hot hardness test gives the most satisfactory results subject to a maximum temperature of about 390 F for ordinary steel balls and about 1470 to 1650 F for sintered carbide balls. This method also has the advantage of relative ease of application and expression of the results in standard Brinell units. For tests at temperatures beyond the range where sintered carbide balls are useable, the impact test has much to recommend it. (K. G. Robinson. *Metallurgia* (British), Vol. 36, May 1947, pp. 45 - 46.)

Armor Plate in Germany

Condensed from "Iron and Steel"

For many years, Krupp in Germany had used only the gas carburizing process for armor plate from 3.9 to 15.7 in. thick. Tank armor was flame hardened 0.4% carbon steel. Induction hardening had been found unsatisfactory for the latter as it was difficult to obtain uniform heating over a wide area.

The armor plate was carburized with a desulfurized coke oven gas. Straightening was done after the first heat treatment and after the final hardening; the first was carried out at the tempering temperature and the last at the stress relieving temperature (212 F).

Specific details are given for a 15.7-in. thick deck armor plate. After rolling, the slab was annealed at 1650 F, pit cooled to 212 to 255 F, heated to 1200 F and held for 24 hr. After straightening and conditioning, the plate was gas carburized for 11 days at 1815 to 1830 F. Subsequently it was air cooled for 30 min., then furnace cooled to 1290 F and finally air cooled. Four grain refinement quenches were used: 22 hr. at 1650 F, 11 hr. at 1645 F, 20 hr. at 1155 F and 19 hr. at 1165 F, with an oil quench after each treatment. The final hardening was done on one side only with moist sand protecting the other side. The

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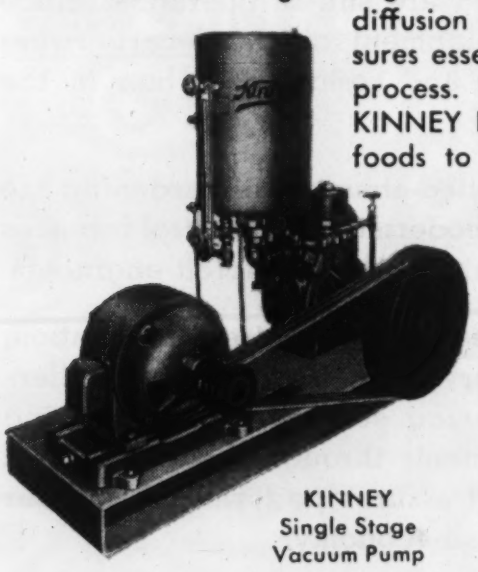

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side to be hardened was heated to 1690 F, then quenched with a water spray.

One ballistic test was made for each 400 tons. Four test pieces for fracture, tensile and impact, were provided on each plate; two were tested after the grain refining process and two after the hardening treatment. (*Iron & Steel* (British), Vol. 20, July 1947, pp. 369-370.)

Forming Magnesium at Room Temperatures

Condensed from "Metal Industry"

Magnesium and its alloys are difficult to form at room temperature, so they are generally heated to about 450 F for deep drawing. Carapella and Shaw (MATERIALS & METHODS, July 1947, p. 127) found, however, that these materials can be drawn successfully at room temperature if the operation is carried out in a series of stages, the load being removed completely between each stage.

It is not easy to understand why this intermittent drawing should increase the ductility. A somewhat similar effect has been observed in lead. It is possible that there may be a rather closer connection between the phenomena than might appear at first, even though the lead will self-anneal and recrystallize at room temperature and magnesium alloys will not. The results of these tests on lead cannot be ascribed simply to self-annealing.

The suggestion which seemed to be most favored at the time was that deformation under the test conditions was principally a grain boundary effect and that during the rest periods a multitude of extremely small crystals was formed at the strained boundaries, thus increasing the grain surface area available for further slip. This explanation is largely speculative. The self-annealing characteristics of lead certainly seemed to be responsible for the great ductility obtained by interrupted straining, particularly since equivalent effects could not be produced in hardened lead alloys which are not self-annealing.

Carapella and Shaw suggest that the "returning action theory" may account for the difference. It is postulated that re-twinning tends to occur the instant the external compressive stresses are relieved. Obviously the benefits therefrom cannot be realized under a continuous application of the load. With cyclic application and release of the load, it appears that the re-twinning action becomes more and more prominent in a way that increases plastic flow. (*Metal Industry* (British), Vol. 70, June 27, 1947, p. 480.)

Quick Facts on Materials

MATERIALS HANDBOOK—SIXTH EDITION. *By George S. Brady. Published by McGraw-Hill Book Co., Inc., New York, 1947. Fabrikoid, 6 x 9 in., 789 pages, plus index. Price $7.00.* This is a new and up-to-date edition of the handbook, which has become virtually a standby in countless engineering laboratories and engineering departments. Covered are all of the engineering materials for manufactured products as well as those in other classifications such as fibers, building materials, and fabrics and organic materials.

A departure from previous volumes is Part II of this edition, which takes up the "Elements of Materials Economics," "Elementary Nuclear Physics," and also covers briefly geology, plant and animal material production and many other specialized topics. Among the many tables and reference data is a list of federal government agencies dealing with the technical aspects of materials resources.

The section covering the properties and uses of material includes approximately 7,500 items.

Protective Coatings

PROTECTIVE AND DECORATIVE COATINGS —VOL. V. *Edited by J. J. Mattiello. Published by John Wiley & Sons, Inc., New York, 1946. Cloth, 6¼ x 9¼ in., 662 pages. Price $7.00.* This volume deals with the Analysis of Resins and Drying Oils, Testing of Metal Finishes, Spectral Characteristics of Pigments and Resinography. The approach to the analysis of resins and associated materials, the manner of employing physicochemical properties of the resins in resin analysis, and the spectrochemical techniques of X-ray radiography and diffraction, ultraviolet, visible, infrared and Raman spectroscopy are discussed.

General principles of laboratory testing are given and advantages and limitations of various tests are analyzed. Spectrophotometric and photographic methods for measuring the spectral characteristics of pigments and surface coatings are described. "Resinography," denoting the graphic study of resins and plastics, is concerned with the

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structure of resins and its correlation with other physical-chemical properties involved in practical performance.

Other New Books

METAL STATISTICS—1947. *Published by American Metal Market, New York, 1947. Cloth, 4¼ x 6¼ in., 816 pages. Price $2.00.* This 40th annual edition follows the same general pattern as previous ones—statistical data on ferrous and nonferrous metals and on miscellaneous economic subjects. The book has been improved in several respects and still maintains its usefulness.

SYMPOSIUM ON ATMOSPHERIC WEATHERING OF CORROSION-RESISTANT STEELS. *Published by American Society for Testing Materials, Philadelphia 3, Pa., 1946. Heavy paper, 6 x 9 in., 83 pages. Price $1.50.* This symposium was presented at the 1946 Annual Meeting of the Society. It is based on the latest data concerning the behavior of the so-called stainless steels on exposure to the atmosphere.

BIBLIOGRAPHY ON HIGH FREQUENCY AND DIELECTRIC INDUCTION HEATING. *Compiled by the staff of Northwestern Technological Institute Library, Evanston, Ill., 1946. Mimeographed sheets fastened together, 8½ x 11 in., 97 pages.* Covers Theory and Background; Methods and Techniques of Heating; Description and Operation of Furnaces; Equipment; Metallurgy; Applications; and Prospects.

ASM REVIEW OF METAL LITERATURE 1946—VOL. 3. *Published by American Society for Metals, Cleveland 3, Ohio, 1947. Cloth, 6¼ x 9¼ in., 811 pages. Price $15.00.* Prepared by Battelle Memorial Institute, this volume covers the monthly instalments published in *Metals Review* from February 1946 through January 1947 and represents a complete survey of the metallurgical literature published in 1946.

FOUNDRY PROCESS CONTROL PROCEDURES (FERROUS). *Published by Special Publications Dept., Society of Automotive Engineers, Inc., New York. Heavy paper, 8½ x 11 in., 145 pages. Price $3.00; $1.50 to SAE members.* A compilation of reports made by the SAE War Engineering Board at the request of the United States Army Ordnance Department covering Steel Castings, Malleable Iron Castings, Gray Iron Castings, and Castings Repair Recommendations for Steel, Malleable Iron, and Gray Iron.

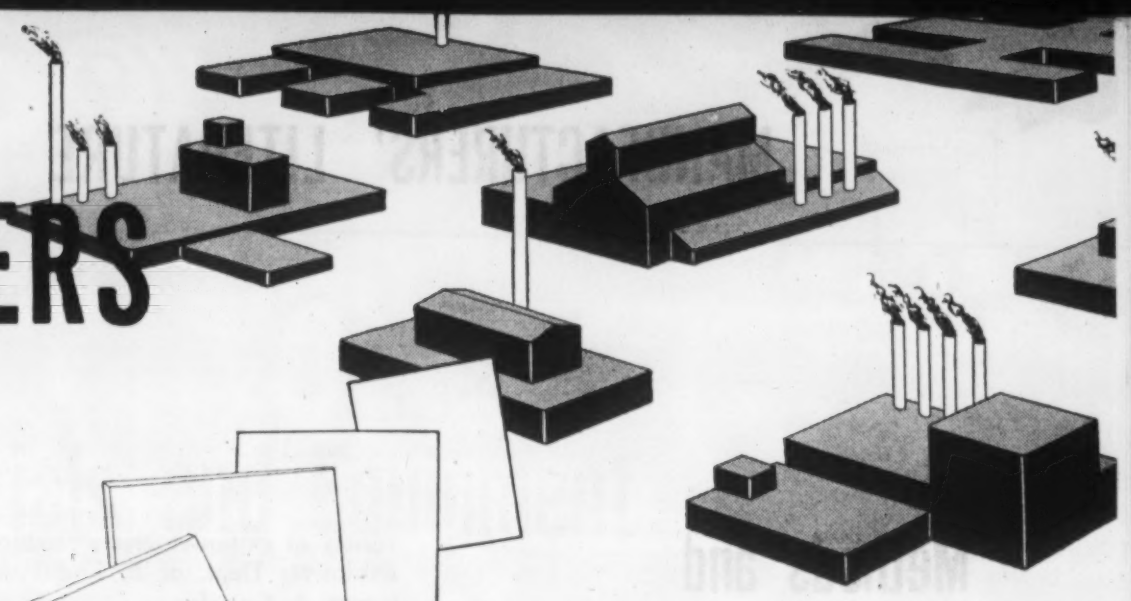
LESSONS IN ARC WELDING—THIRD EDITION. *Published by Lincoln Electric Co., Cleveland, Ohio, 1947. Simulated leather, 5¾ x 8¾ in., 158 pages. Price 50c in U.S.A.; 75c elsewhere.* Lessons 1 to 32 inclusive are devoted to the welding of mild steel in all positions, while lessons 33 to 58 are concerned with the advanced courses in alloy welding, sheet metal welding and pipe welding. Questions and answers are separately grouped in the last 30 pages. There are 228 illustrations.

METALLIC TESTING AND HEAT TREATMENT. *By Leofric Fenn. Published by Scientific Publishing Co., Manchester, England. Limp cloth, 4¼ x 7¼ in., 61 pages. Price 5/.* Basic principles are set forth for students. Fifty questions and answers are listed at the end of the text. Illustrated.

MODERN POLISHES AND SPECIALTIES. *By W. D. John. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y., 1947. Cloth, 5¾ x 8¾ in., 313 pages. Price $7.50.* Each chapter discusses the basic raw materials used in the polishes under consideration and then gives tested formulas for these polishes. Included are chapters on: The Vegetable Waxes, White Floor Polishes, The Mineral Waxes, The Insect and Animal Waxes, Synthetic Waxes, Furniture Polishes and Metal Polishes.

HARDENABILITY OF ALLOY STEELS. *Published jointly by Society of Automotive Engineers and American Iron & Steel Institute, New York, 1947. Paper, 6¼ x 9 in., 146 pages. Price $1.00 to SAE members; $2.00 to non-members.* Offers current data on designing, testing and ordering steels by hardenability-band specifications.

MANUFACTURERS LITERATURE



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Stainless and Heat Resisting Steels. The chemical analyses, physical properties, corrosion resistance rating and fabricating properties of a variety of stainless and heat resisting steels produced by the Jessop Steel Co. are included in this 12-page bulletin. (1)

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Die Casting Analysis. The advantages of having your die casting problems "Doehler-ized"—a Doehler-Jarvis Corp. engineer to study your job, present method of production, machining costs, and assembly problems, and then to give a die casting quotation and recommendation—are presented in a 4-page, illustrated bulletin. (4)

Die Casting. Facilities of the Electric Auto-Lite Co. for machining, finishing and plating all zinc or aluminum die cast parts are described and illustrated in a new 16-page bulletin. (5)

Steel Wire. The facilities of the Johnson Steel & Wire Co. for making a variety of round and shaped steel wires are profusely illustrated and described in an attractive, 44-page bulletin. Tables of coil spring load deflection, hardness conversion numbers for steel, and physical properties of steel wire are included. (6)

Plastic Knobs, Dials and Control Balls. Specifications for a variety of plastic instrument knobs, pointer and lever knobs, terminal and control knobs, control balls, etc. are included in this 12-page, illustrated bulletin, No. 103A, published by Kurz-Kasch, Inc. (7)

Alloy Castings. The many applications of Fahrite heat, abrasion and corrosion resisting alloy castings for industrial heat treating are profusely illustrated and described in an 8-page bulletin, No. F-347, issued by the Ohio Steel Foundry Co. (8)

Design-Strengthened Metals. Typical applications of both ferrous and nonferrous Rigidized (design-strengthened) metals with perforations, with 18 standard Rigid-Tex patterns ranging in depth from 0.005 to 0.320 in. to choose from, are illustrated and described in a 6-page folder offered by the Rigid-Tex Corp. (9)

Electrical Laminations. Complete data on stock lamination dies, and numerous tables on weights, characteristics, suggested applications and specifications of electrical steels are all compiled into a 16-page, illustrated bulletin, No. 47, issued by Thomas & Skinner Steel Products Co. (10)

Plug Buttons. A wide variety of Dot plug buttons as covers for holes drilled, punched or molded in metal or plastics are illustrated and described in a new engineering data catalog, Section D, offered by the United-Carr Fastener Corp. (11)

Light Metal Forgings. This 4-page bulletin describes and illustrates large light metal press forgings made possible by the 18,000-ton die forging press now in operation by the Wyman-Gordon Products Corp. (12)

Plastics

Laminating Resins. The Plastics Div. of the American Cyanamid Co. has recently published a 4-page, profusely illustrated bulletin describing Laminac laminating resins, their applications and potential uses. (13)

Plastic Surfacing. The many advantages of fusing Kimpreg plastic surfacing to plywood, which produces a beautiful plastic finish with a flint-like, permanently snag-proof surface, are listed in an 8-page, illustrated bulletin issued by the Plastics Div. of Kimberly-Clark Corp. (14)

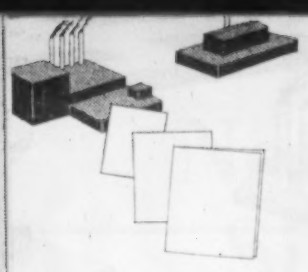
Plastic. Complete technical data on polystyrene, a modern rigid plastic suitable for most injection molding, extruding and fabricating operations, are presented in this single sheet, No. N-9842, offered by Koppers Co., Inc. (15)

Nonmetallics

S.A.E. Felts. Fourteen samples of S.A.E. precision-cut felts, their specifications and applications are presented in a comprehensive chart by the Booth Felt Co., Inc. (16)

Abrasive Resisting Rubber. This illustrated catalog, section No. 9010, four pages, discusses Armorite, a tough abrasion resisting rubber for use on agitator bars, linings, hoppers, sand blast equipment, etc. B. F. Goodrich Co. (17)

Vulcanized Fiber. Both Ohmoid and Fyberoid vulcanized fibers in sheets, rods, tubes, continuous rolls and coils, and special shapes that are tough, strong, dense, yet light in weight and attractive are discussed in a 4-page, illustrated bulletin issued by the Wilmington Fibre Specialty Co. Typical applications are included. (18)



MANUFACTURERS' LITERATURE

Methods and Equipment

Heat Treating

Tube Furnaces. Specifications and prices of a variety of Unit-Package high temperature tube furnaces for temperatures up to 2650 F are included in this 4-page, illustrated bulletin, No. 459-47, just published by the Burrell Technical Supply Co. (19)

Flame Hardening. The principles and operation of the Flamatic machine for flame hardening are described and illustrated in a 20-page bulletin, No. M-1611, offered by the Flamatic Div. of the Cincinnati Milling Machine Co. (20)

Surface Hardening Stainless Steels. Bulletin No. 21, four pages, describes and illustrates a process for surface hardening stainless steels of all types to resist wear, abrasion, galling or seizing. The Drever Co. (21)

Induction Heating. Specifications, applications and prices of a portable bench-type induction heating unit for the soldering of small metal parts and assemblies are included in this 4-page, illustrated bulletin issued by the Marion Electrical Instrument Co. (22)

Sludge Dissolver. Petroflo, a dissolver in liquid or powder form that eliminates oil sludge in quenching tanks used for tempering of metal products, is featured in a 4-page, illustrated bulletin offered by the Xzit Sales Co. (23)

Welding and Joining

Arc Welding Composite Dies. The correct methods of arc welding both steel and cast iron dies are presented by Ampco Metal, Inc. in a 2-page procedure sheet, No. D-2326. (24)

Industrial Adhesives. The types and uses of a complete line of Bostik industrial adhesives produced by the B. B. Chemical Co. are presented in a comprehensive, 44-page data sheet manual. (25)

Explosive Rivets. Thirteen data sheets are compiled into one folder, No. A-6085, to offer complete data, including materials, sizes, riveting irons, strengths, etc., on a variety of explosive rivets produced by the Explosives Dept. of E. I. duPont de Nemours & Co., Inc. (26)

Welding of Nickel Alloys. The materials required for the metal-arc, oxyacetylene, and submerged melt welding of nickel and high nickel alloys are suggested in this 16-page, illustrated bulletin published by the International Nickel Co., Inc. Also included are recommended amperages, type of welding rods to use, and the proper flux to select. (27)

Portable Welders. A variety of portable-type precision welders produced by the Precision Welder & Machine Co. are described and illustrated in a 4-page bulletin. (28)

Forging and Forming

Eliminated Machining Through Forging. How costly machining was eliminated in a specific power transmission part through the use of various forging operations suggested by the Champion Machine & Forging Co. is discussed in a 4-page, illustrated bulletin. (29)

Power Bending Presses. Details of construction and specifications of a variety of Sturdybender production-rated power bending presses in capacities of 60 to 120 tons are included in an attractive, 40-page, illustrated catalog, No. S-1000, just published by the Cyril Bath Co. (30)

Hydraulic Presses. The selection, application, design, construction, testing and installation of hydraulic presses are all interestingly illustrated and described in a 16-page bulletin, No. 147, offered by the Lake Erie Engineering Corp. (31)

Bending Machines. A complete line of bending machines designed to speed up the production of bends in pipes, bars, tubes and extruded shapes are described and illustrated in an 18-page catalog offered by the Pines Engineering Co., Inc. Specifications are included. (32)

Hole Punching Units. The second edition of an attractive, 32-page catalog, No. BL, profusely illustrates and describes a wide variety of Type BL hole punching units for punching sheet metal up to 1/8-in. thick, produced by the Wales-Strippit Corp. Specifications are included. (33)

Machining

Grinding Wheels. Typical applications, directions for use and specifications of a variety of Bayflex grinding wheels for straight and contour cutting and finishing are included in this 4-page, illustrated bulletin offered by the Bay State Abrasive Products Co. (34)

Mounted Wheels. A wide variety of wheel shapes and sizes, abrasives and coated abrasive disks, sleeves and cartridge rolls available for use on light weight, high speed portable grinders are described and illustrated in a new 32-page bulletin offered by the Carborundum Co. (35)

Cutting Oils. The physical properties of the improved Cut-Max 100, 200, 300 and 400 series of cutting oils are included in a 4-page, illustrated bulletin issued by E. F. Houghton & Co. (36)

Automatic Chucking Machines. This 12-page bulletin profusely illustrates and describes Models 475, 49 and 412 work rotating four-spindle, automatic chucking machines produced by the New Britain-Gridley Machine Div. of the New Britain Machine Co. Specifications are included. (37)

Mounted Wheels and Points. Specifications and prices of a complete line of mounted wheels and mounted points, produced by the Norton Co., are presented in a 20-page, illustrated booklet. (38)

Precision Grinders. Two new precision grinders, 10-in. and 20-in. models, for high-speed stellite and tungsten carbide lathe-shaper-planer and special purpose template-controlled tool grinding are described and illustrated in an 8-page bulletin offered by the Oliver Instrument Co. Specifications are included. (39)

Buffing and Polishing Machine. A type V-1 semi-automatic buffing and polishing machine that is completely equipped with motor drive, has all the vital mechanisms fully enclosed, and has all moving parts on Timken bearings is featured in a 4-page, illustrated bulletin issued by the Vanoni Machine Corp. (40)

Industrial Tools and Machinery. A complete line of industrial tools and special machinery for milling, drilling, tapping, grinding, slothing, turning and broaching operations are described and illustrated in a 32-page bulletin, No. ME-9, issued by the Zagar Tool, Inc. A price list and specifications are included. (41)

Cleaning and Finishing

Metal Cleaning. Faster and better metal cleaning in the nonferrous foundry through the use of the airless Wheelabrator, produced by the American Wheelabrator & Equipment Corp., is discussed in this 12-page, illustrated bulletin. (42)

Finishing Equipment. A complete line of gas, oil, electric and steam ovens, dryers, air heaters, spray booths, conveyors, etc. produced by the Despatch Oven Co. is

New Materials and Equipment

Flame Hardening Machine Employs New Techniques

A new development employing flames r the surface hardening of parts in pro- uction quantities has been announced by e *Cincinnati Milling Machine Co.*, Cin- nnati 9, Ohio. The machine incorporates any new improvements in flame harden- g techniques.

An important feature of the machine, nown as the Flamatic, is the electronic mperature control system, which permits pid heating of parts to the desired pre- t temperature, followed by an oil quench. is claimed that the surface temperature the instant the part enters the quench is eld within ±5 F of the desired value in e critical transformation range.

Rapid heating makes it possible to con- ne the heat to the surface of the part, aving the core relatively cool, and per- itting core properties to be established by revious heat treatment. Uniform depth of eat penetration is said to be achieved, hich factor, combined with the oil uench, results in negligible distortion.

Equipped with standard flame heads, the achine is adaptable to harden gears, hafts, barrel-type cams, pinions, and other arts that lend themselves to rotation. With pecial flame heads and work holding fix- ures, the machine will accommodate a ider range of parts. In general, the range f parts includes shafts up to 18 in. long, nd parts with diameters up to 8 in., with correspondingly smaller lengths.

The machine is 7 ft. 8½ in. wide, 5 ft. 5 in. deep, and 5 ft. 6 in. high, and weighs 8500 lb. ready for operation. Basically, it consists of a work table built over a conveyorized quench tank, flame head assemblies adjustably mounted on the work table, and a spindle to which a work holding device is attached, centered between the flame heads.

Operation is fully automatic except for the loading of parts. The operator places the work piece on the holding fixture, presses the automatic cycle start button, and the cycle is completed without further action by the operator. The spindle starts rotating, the flames are ignited, and the surface of the part is heated to the preset temperature. At this moment the flames are extinguished, the spindle stops rotating and retracts, stripping the work piece off the holding fixture and into the quench tank. The operator can then place another part in position for the next cycle.

This flame hardening machine has electronic temperature control.

New Welding Electrodes Announced

A new wear-resistant bronze welding rod was announced recently by the *Air Reduction Sales Co.* Known as Airco 28, the manufacturer recommends it for building up wear-resistant surfaces subject to heavy loads, especially where elevated temperatures are encountered. It is particularly suitable for building up worn piston heads, valve bull rings, driving box laterals, shoes, wedges, and similar wearing parts.

A new electrode, Hobart No. 13, designed to simplify the welding of light gage mild steel, has been announced by *Hobart Brothers Co.*, Troy, Ohio. Low penetration, ease of handling and steady uniform transfer of metal are said to make this electrode extra fast for out of position welding on light gage sheet metal. It is also recommended for welding light sections of mild steel to heavier ones.

A new electrode for hard-surfacing applications where resistance to impact, wear, and abrasion is required has been announced by the *Electric Welding Div., General Electric Co.*, Schenectady, N. Y. Designated Type W-94, the new electrode will work harden to over 50 Rockwell C. It operates on a.c. or d.c. reverse polarity.

The *Eutectic Welding Alloys Corp.*, 40 Worth St., New York 13, has recently introduced two new electrodes. EutecTrodes 67 AC and 670 DC have a high alloy content developed for joining, filling, filleting and overlaying all types of steel where high tensile and impact strength; good heat, corrosion, and wear resistance; and high hardness values are required. It can also be used as an overlay material on cast iron. EutecTrodes 66 AC and 660 DC are flux-coated electrodes for welding of all types of steel. They are said to produce a smooth, high tensile, crack-resistant weld, and are particularly suitable for vertical position welding. For welding low carbon steel to high carbon, this rod can be used.

A new silver solder which is said to have the advantages of high capillary action, exceptional tensile strength, and good appearance after brazing, is available from *All-State Welding Alloys Co.*, 96 W. Post Rd., White Plains, N. Y. Its silver content is 20%; has a melting temperature of 1,430 F and a shear strength of 145,000 lb. per sq. in.

Bench Type Oven Furnace Has Improved Design

A small oven furnace intended for use in small tool shops and other shops not requiring elaborate or expensive heat treating equipment has been designed by *Eclipse Fuel Engineering Co.*, 746 S. Main St., Rockford, Ill.

The furnace shell is of heavy gage welded sheet with reinforcements. Heavy cast sections are used at points subjected to heat such as door, door frame, top casting and flue outlets.

Primarily designed for use where low pressure air (from 10 to 16 oz.) is available, combustion equipment includes burner and McKee proportional mixer, which provides single valve temperature control. Temperature range is 1400 to 1600 F.

These bench type furnaces are suitable for intermittent use in hardening punches, dies and small tool or brazing applications in shops where space is limited.

● A new stop-off lacquer, Kote-Masq, has been announced by the *Hanson-Van Winkle-Munning Co.*, Matawan, N. J. This product can be used in any electroplating, electrocleaning or anodizing solution. It can be stored in the original shipping container or one of glass; not plain tinned or galvanized containers. It can be removed with a chlorinated solvent liquid or in a vapor degreaser.

Thermoplastic Material Offers New Properties

A new product said to offer properties not previously available in a thermoplastic material is now in commercial production by *B. F. Goodrich Chemical Co.*, 324 Rose Bldg., Cleveland 15. Designated Geon polyblend 500 x 503, it is the first in a series of colloidal blends of Geon polyvinyl chloride resin and Hycar nitrile rubber polymers.

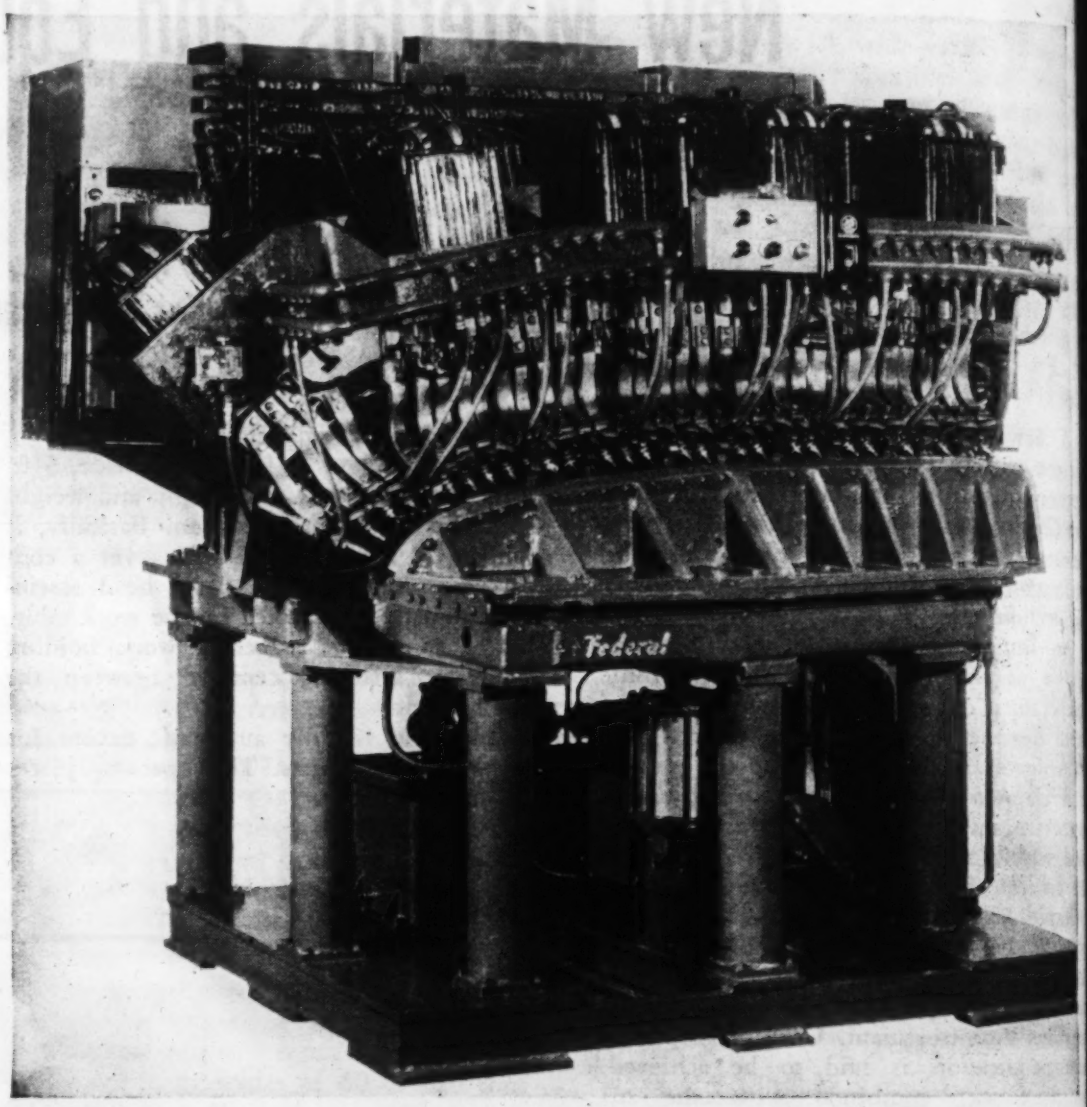
This material combines the toughness and chemical resistance of polyvinyl chloride with the solvent resistance and flexibility of nitrile rubber. It is also unique in that the valuable characteristics of vinyl elastomers are achieved with no liquid plasticizer. The nitrile component of the polyblend serves as a non-extractable, nonmigrating, polymeric plasticizer. If desired, conventional liquid plasticizers may also be added.

It has been especially designed for extruding and calendering and is well adapted to embossing and press-polishing operations. In the electrical industry, polyblend may be used as covering for cables containing vinyl insulated wires since there is no danger of plasticizer migration. This elimination of plasticizer transfer is also important to food packaging and adhesive applications.

New Developments in Welding Equipment

Multi-Point Spot Welder

A new type multi-point spot welder has been developed for spot welding front fender stampings to fender rails by the *Federal Machine & Welder Co.*, 10 Dana St., Warren, Ohio. As the equipment is set up in the automobile plant, two left fender welders and two right fender welders provide a production in excess of 40 welded assemblies per hr. per machine.



Indexing of the fixture, operating of the welding gun, and welding are fully automatic on this spot welder for auto fenders.

The fabricated steel main frame of the machine supports the stationary die unit and houses the welding transformers, clamping cylinders and sequencing control. The fabricated steel clamping arm, which holds the 32 spring-loaded point body units, is actuated by two cylinders through a system of toggle links. The fixture stroke of from 6 to 8 in. permits ease of loading, unloading, dressing or changing of dies and electrodes.

A hydraulic pumping unit supplies the necessary oil pressure for operating the 32 double-acting welding guns, which are equipped with water-cooled point holders and welding points. There are nine welding transformers, eight of which are employed when making 32 spot welds on the normal size fender, and all nine of which are employed when welding the larger size fender on which 34 spot welds are made. The die holders and dies are interchangeable to allow for welding the different sizes.

Automatic Welding Machine

A new electronic automatic welding machine, said to provide faster welding and less passes per seam, has been announced by the *Niagara Machine & Tool Works*, 683 Northland Ave., Buffalo, N. Y.

The electronic control provides variable speed of the machine along a track so that the length of welding is governed only by the track length. Welds perpendicular to the track are accomplished by traveling the welding head at a variable speed along the cantilever beam. Push-button control brings the power elevated beam to any height position, thereby providing maximum speed in changing from one setup to the next, whether the job be a long slender member or a massive frame. All welding adjustments and machine movements are controlled from one push-button station.

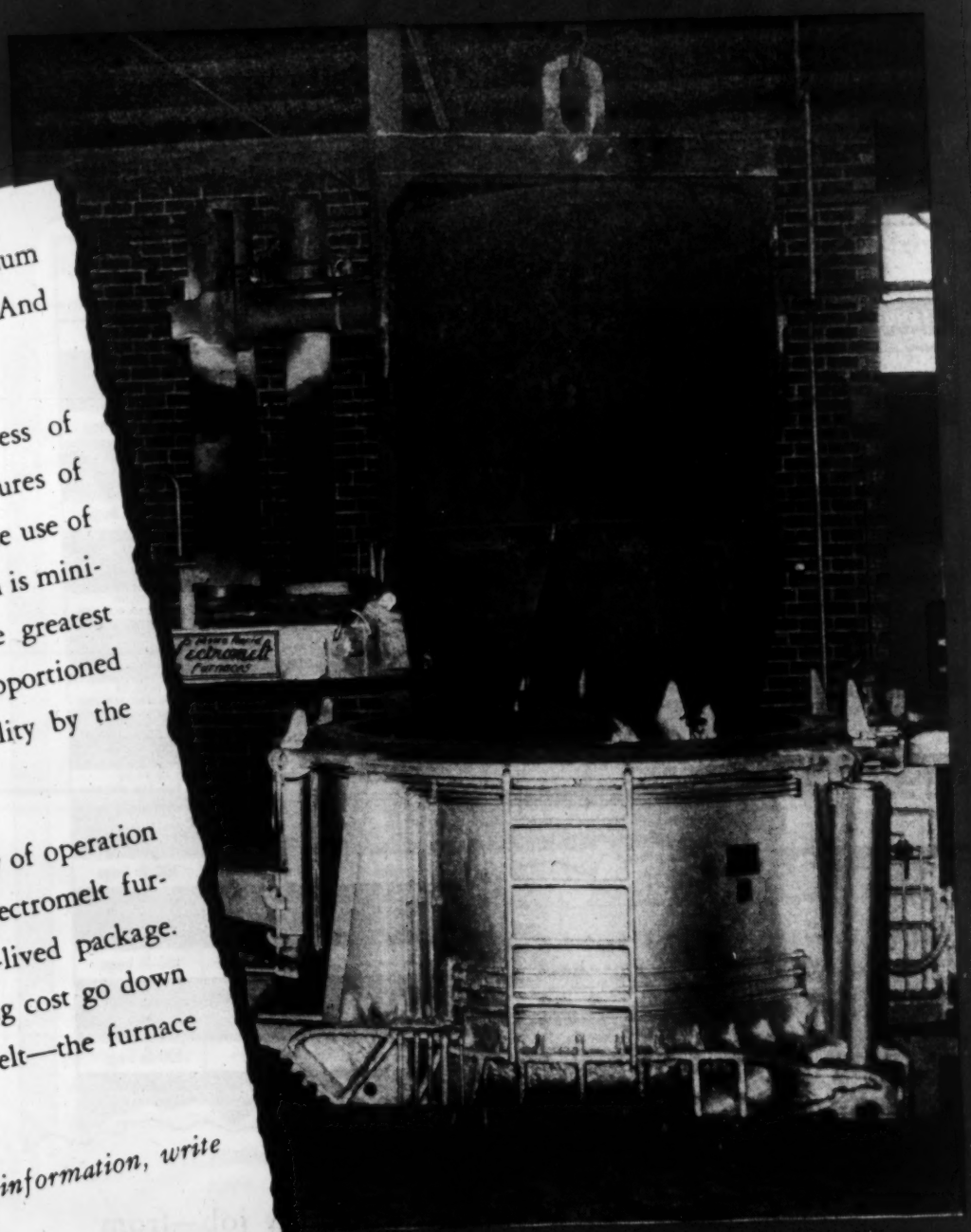
Bench Spot Welder

An inexpensive bench model 1-kva spot welder is available from *Rex Welder & Engineering Co.*, Kansas City, Mo. It plugs into any standard outlet carrying 110-v. a.c. current.

It has an air cooled transformer, removable standard No. 1 Morse taper tips, and welds up to 24-gage mild steel. Operation is controlled by a hand lever on the right side of the welder, but a foot operated attachment will be provided if desired.

Built to Last . . .
And to Save You Money

MOORE RAPID
Lectromelt
FURNACES



Long, efficient service with minimum maintenance costs—that's Lectromelt. And that's money in your pocket.

Simplicity of design and ruggedness of construction are characteristic features of Lectromelt furnace equipment. The use of complicated operating mechanism is minimized, and parts subject to the greatest stress and wear are carefully proportioned for extra strength and durability by the best materials.

Flexibility, rapidity, economy of operation —these characteristics of Lectromelt furnaces are yours in a long-lived package. Watch your total operating cost go down when you select Lectromelt—the furnace that's built to last.

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PITTSBURGH 30, PA.

Tells at a glance

the right refractory for every job

READY REFERENCE CHART ON JOHNS-MANVILLE REFRACTORY PRODUCTS

PRODUCT	Highest Recommended Service Temperature	Air or Heat Set	Pounds Required for 1 cu. ft. Construction	Estimated Lbs. for Laying 1000 Brick	Containers
STANDARD FIRECRETE	2400°F	Air Set (Hydraulic)	110	———	100-lb bags
Intermediate Heat Duty USES	Domestic Oil Burner and Stoker installations, Furnace Door Linings, Bottoms, Cov... Special Shapes and many other types of monolithic construction as thin as 1½"				
H. T. FIRECRETE	2800°F	Air Set (Hydraulic)	115	———	100-lb bags
High Heat Duty USES	Applicable for use against extremely high temperatures otherwise similar in properties and uses to Standard Firecrete				
L. W. FIRECRETE	2400°F	Air Set (Hydraulic)	70	———	100-lb bags
Insulating Refractory Concrete USES	...Floor Liners, Covers, Pipe Lining and other monolithic constructions requiring ... lightweight, low conductivity, easily placed refractory. For many special condi... ...used in combination with either Standard or H. T. Firecrete				
HELLITE	3000°F	Air	———	200-400 lbs+	5,10,25,50, 100,250,500,850
Medium, Air Setting USES	Laying Fire Brick and wash coating. Furnished in proper consistency for shallow ... with hot or cold, with trowel or paddle. Thinned with water for laying Fire Brick				
No. 20	2700°F	Air	———	200-400 lbs+	5,10,25,50 100,250,500,850
Hard, Air Setting, USES	Laying Fire Brick, wash coating, used with crushed Fire Brick for making a heavy ... patching material. No. 20 is very adhesive				
No. 2986	3200°F	Air	———	200-400 lbs+	5,10,25,50 100,250,500,850
Hard, Air Setting, Highly Refractory USES	Laying Fire Brick, Super Duty Fire Brick, High Alumina and Insulating Fire Brick ... Wash Coating. A highly refractory, high water retention mortar				
			———	600 lbs+	100-lb bags
	...milled, heat setting mortar specially adapted for ... cushion joint				
			———	200-400 lbs+	100-lb bags
	...and similar to No. 31 Cement but finely ground				
			———	600 lbs+	100-lb bags
	...ing that or cold. A coarsely milled, air set... ...Laying Fire Brick with ...				

Hang this easy-to-use chart in your office or shop— it's yours for the asking.

It lists the correct refractory cement for every job—from door linings to plugging air leaks in boiler settings. It also shows highest recommended service temperatures, type of set, pounds required per cubic foot of construction or per thousand brick, and how packaged.

Each recommendation is based on more than forty years' performance, and backed by scientific research.

Ask your J-M Distributor for this free chart or write to Johns-Manville, Box 290, N. Y. 16, N. Y.

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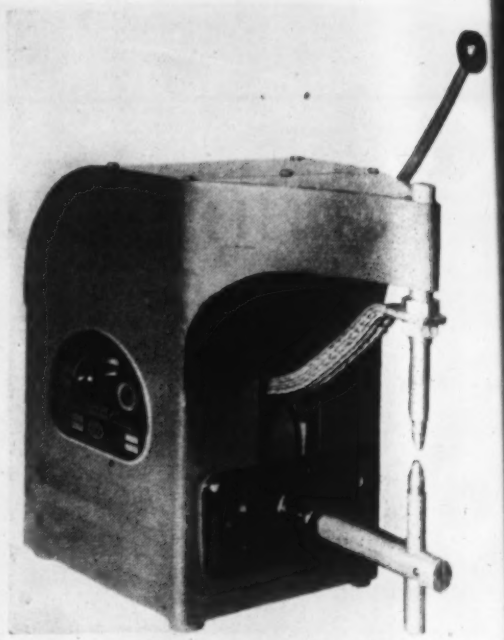
Johns-Manville REFRACTORIES



This small bench spot welder is suitable for sheet metal shops, repair shops of all types, and all light manufacturing.

The machine stands 14 in. high and weighs approximately 76 lb. Throat depth is 6 in. and the lower horn is adjustable.

Multiple Welder

Hot upsetting, spot welding and projection welding of intricate small parts to a steel panel are accomplished in one operation on this multiple resistance welder manufactured by *Sciaky Bros., Inc.*, 4915 W. 67th St., Chicago. The welder is an open-throated assembly of individually controlled welding guns. Transformers and control equipment are compactly mounted on either side.

The parts to be welded are placed in a locating jig by one operator while another operator places another loaded jig over the retractable lower platen. Releasing jig drops all parts into lower dies. Meanwhile, operation on other side of machine is placing panel in position. An air cylinder then moves the platen up until a special contact is made with conductor from transformer; the upper electrodes, which are shaped to fit the parts, are then in welding position. The upper electrodes can be positioned at will to accommodate other types of panels.

Water Saver

A new automatic device for turning on or shutting off the cooling water in a welding operation has been introduced by *Weltronic Co.*, Dept. K, 19482 W. Eight Mile Rd., Detroit 13, Mich., for use with any type welding machine.

This water saver is so designed that its two control relays and the solenoid operated water valve are de-energized if the welding machine is stopped for a period of time longer than 30, 60 or 90 sec.—the three time ranges available. De-energizing the water valve stops the flow of cooling water; starting the welding machine energizes its initiating transformer, which is connected to the air solenoid valve coil on the welding machine.

Installation of this device is said to reduce condensation, avoiding transformer shorts; cut water use during idle time; ease overloaded disposal systems, with a saving to pumps; reduce sweating, rust and corrosion.

A.C. Arc Welders

A complete line of a.c. arc welders has been announced by the *Harnischfeger Corp.*, 4400 W. National Ave., Milwaukee, Wis. All models are supplied with this company's "Dial-lectric" control. It eliminates the need for moving coils or cores, worm gears, sprockets and chain or lever adjustments. Current selection is made by turning a single dial which requires but a three-quarter turn to cover the full welding range of the machine, from minimum to maximum capacity.

All industrial models of this series are designed for remote control. Another improvement is the high-low welding range. There are two separate ranges, a high for general-purpose welding and another for light-gage welding. Welders are offered in intermittent industrial and heavy-duty models, ranging up to 625 amp.

Lightweight Arc Welder

A new lightweight engine-driven welder, designed for 200 amp. at 30 v. on the basis of 50% duty cycle, is available from *Westinghouse Electric Corp.*, Pittsburgh 30.

The design characteristics of the generator are said to provide easy striking and maintenance of the arc for shop quality welding on steel, cast iron, alloys, hard surfacing aluminum and brass.

The welding current is adjusted over a range from 30 amp. at 20 v. to 250 amp. at 30 v. in four major steps by plugging screw locking plugs on work and electrode leads. Intermediate values of current are obtained by rheostat control. Polarity is controlled by interchanging work or electrode lead connections. This welder is available either as a portable or stationary model.

● The *Stearns Magnetic Mfg. Co.*, Milwaukee 4, has designed an electro magnet for holding metal inserts like washers, disks and tacking devices in a predetermined pattern in material during molding operations. This magnet operates on d.c. and is designed for popular voltages or to operate on a.c. with rectifier.

Shaper Fills Gap Between Large and Small Types

A new 12-in. precision shaper has been announced by *Sheldon Machine Co., Inc.*, 4258 N. Knox Ave., Chicago. This shaper is designed to fill the gap between the large, heavy industrial shapers and the small bench type machines, and to do all shaper work within its capacity.

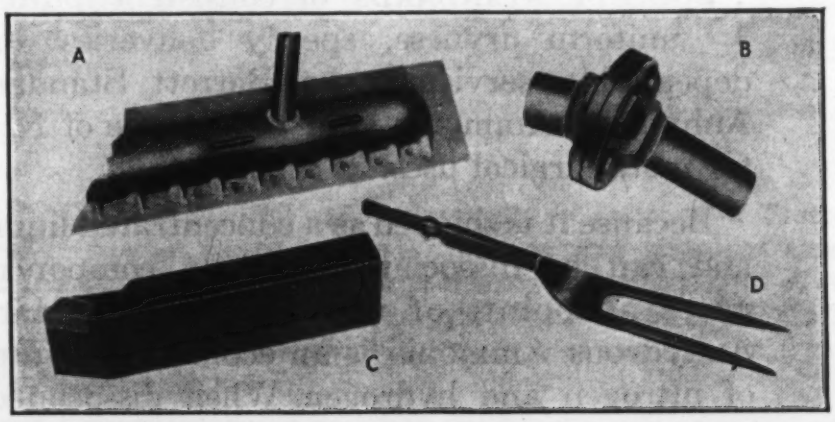
A variable speed motor drive provides all speeds from 12 to 180 strokes per min. It has automatic cross feeds in both directions of from 0.0025 to 0.0175 in. Its swivel table and swivel vise come as standard equipment. Controls are conveniently located within reach from the operating position. The shaper has a heavy cross rail, large dove tails, broad ways and extra overhang of the ram.

Give Your Production a Lift with APW

NO. 217 SILVER BRAZING ALLOY

APW No. 217 is tops for low temperature production brazing of steel, stainless steel, alloy steel, copper, brass, bronze, Inconel and monel metal. Only small amounts are needed to make clean, sound, leak-proof joints.

Tested and approved by leading manufacturers . . . here are a few typical applications:



A-Stainless Steel & Copper Refrigerator Sub-Assembly. B-Brazed Steel Universal joint. C-Carbide Tool Tip brazed to Shank. D-Stainless Steel Fork Assembly.

APW NO. 217 ALLOY IS FURNISHED IN WIRE COILS, STRIP, SHEET, WIRE RINGS, WASHERS, DISCS AND SPECIAL INSERTS.

ANY FORM • ANY SIZE ANY QUANTITY.

THERE'S AN APW LOW TEMPERATURE SILVER BRAZING ALLOY FOR EVERY PURPOSE

●

APW No. 369 PASTE FLUX

Gives maximum protection to metal surfaces being joined and actively promotes flow of molten alloy. Easily soluble in hot water.

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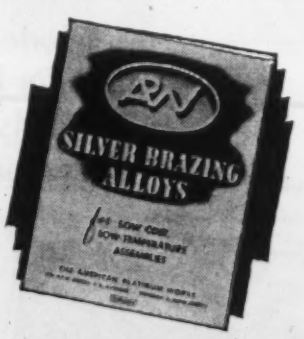

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PRECIOUS METALS SINCE 1875

For { NITRIDING STEELS
BRIGHT ANNEALING
ATOMIC WELDING AND BRAZING
CONTROLLED ATMOSPHERES
POWDER METALLURGY SINTERING ATMOSPHERE
REDUCTION OF METALLIC OXIDES

BARRETT STANDARD ANHYDROUS AMMONIA

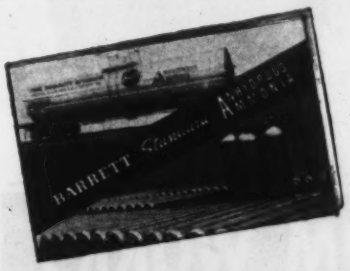
Minimum Purity 99.95% NH_3 . . .
Oxygen Free . . . Very Low Dew Point

BARRETT STANDARDS of consistent purity, uniform dryness, speedy deliveries and dependable service make Barrett Standard Anhydrous Ammonia your best source of NH_3 for metallurgical uses.

Because it is shipped as a concentrated liquid and can be dissociated into its component gases at points of use, Barrett Standard Anhydrous Ammonia is an economical source of nitrogen and hydrogen. When dissociated, each pound of Barrett Standard Anhydrous Ammonia produces approximately 11 cubic feet of nitrogen and 34 cubic feet of hydrogen.

Barrett Standard Anhydrous Ammonia is available in 50, 100 and 150-pound cylinders from conveniently located warehouses; or, for larger users, in 26-ton tank cars.

Modern metallurgy is finding more and more uses for Barrett Standard Anhydrous Ammonia. The advice and help of Barrett technical service men are yours for the asking.



This interesting and helpful booklet is packed with useful information on Anhydrous Ammonia. You can obtain a copy without charge or obligation, by requesting it from the address below.

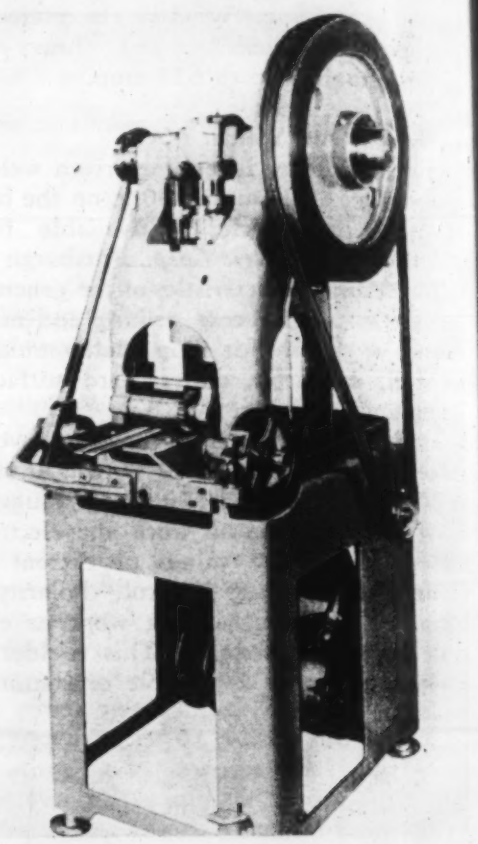
THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N. Y.
ONE OF AMERICA'S GREAT BASIC BUSINESSES

Barrett

Stamping Press Features Roll Feed

A 12-ton high-speed automatic press with automatic roll feed and variable speed drive has been introduced by *Di Machine Corp.*, 2711 W. Irving Park Rd., Chicago 18.

The press takes standard die sets measuring to 8½ by 6¼ in., or special die sets measuring to 8 by 12 in.. The shut die height over the bolster plate is 6 in. The adjustable automatic roll feed mechanism, which operates by means of an eccentric body on the crankshaft, is an integral part of the machine. Stock to 4½ in. wide may be employed, and the length of feed is adjustable to 6 in. The feeding mecnanism provides accurate feeding for the use of



The roll feed provides accurate feeding for this automatic press.

progressive dies as well as for the use of blanking or compound dies. The variable speed drive permits operation of the press between 65 and 300 strokes per min. The press is available with a 1, 1½ or 2-in. stroke.

The press occupies a floor space of 32 by 40 in. It has an overall height of 66 in. and weighs approximately 1500 lb.

● Silcote is the name of a new material which produces protective coats of silica on front surface mirrors by low-temperature, low-pressure evaporation. Front surface mirrors with this material, manufactured by *National Research Corp.*, 70 Memorial Drive, Cambridge, Mass., have a resistance to abrasion more than 1600 times that of an unprotected mirror. In actual tests an unprotected front surface mirror was damaged by 25 cycles of an abrasion tester while the protected surface did not show damage after 40,000 cycles of the same tester.

Hydraulic Power Feed for Drill Presses

The *Canedy-Otto Mfg. Co.*, Chicago Heights, Ill., announces the development of a hydraulic power feed for their sliding head model drill presses.

The new attachment makes the Canedy-Otto machine fully automatic, instead of semi-automatic as at present. It is said to provide accurate control in operating under various conditions.

The hydraulic power feed can be operated automatically, semi-automatically or manually. It is provided with convenient adjustment for obtaining various rates of feed. Units equipped with this feed may be used for honing, lapping, tapping and drilling operations.

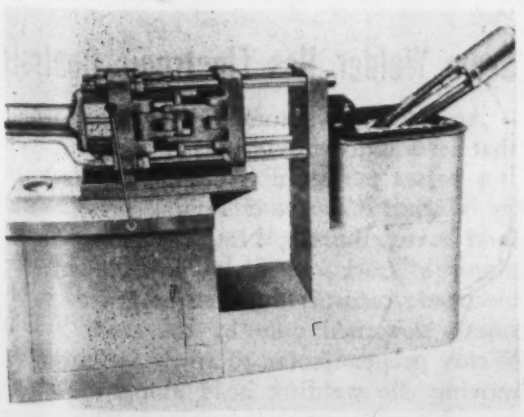
Die Casting Machine for High Quality Zinc Base Castings

A new hydraulic hot chamber machine, designed for the die casting industry, is being manufactured by *Production Engineering Consultants,* 3771 Edgehill Drive, Los Angeles 16, Calif. It embodies cold chamber injection pressure for a 2-lb. shot, either center gated or 3 in. below. It is 10 by 10 in. between bars and will take die thicknesses from 6 to 12 in. and with die half separation of 6 in.

The machine is designed so that it cannot be shot when the dies are open and it uses nonflammable oil which is furnished as standard equipment. The high platen center line of 38 in. is said to reduce operator fatigue.

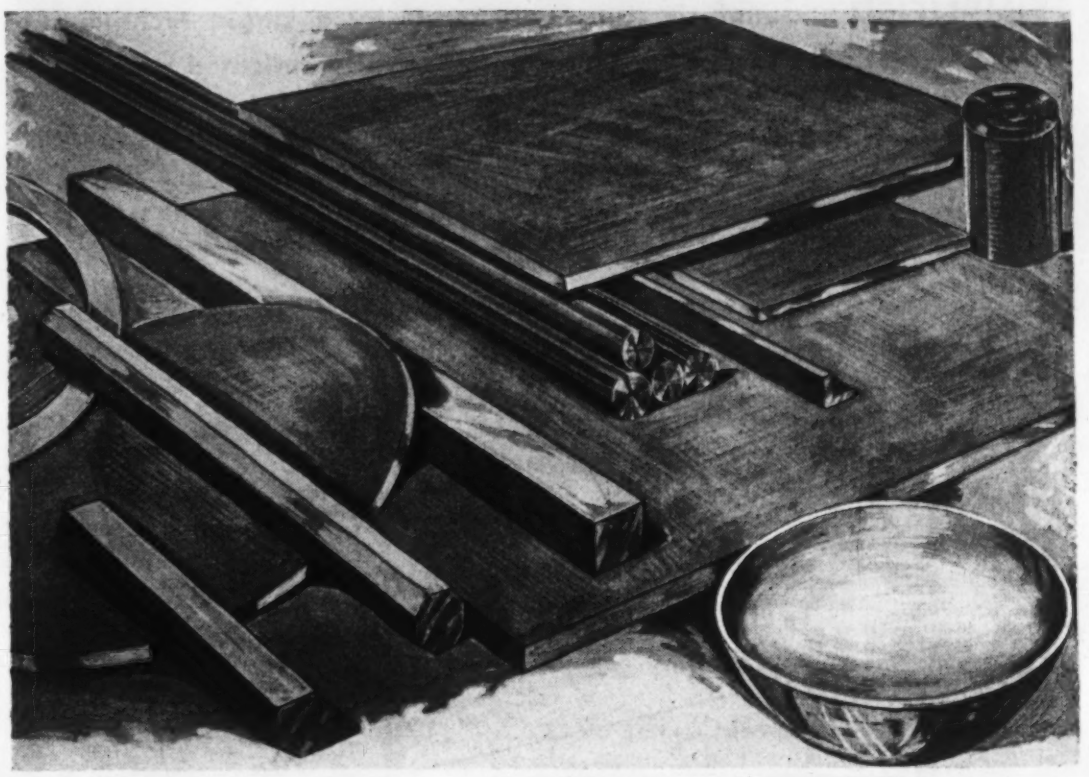
Casting operation is by a single lever control, which when moved full forward closes the die and shoots, and returning the lever opens the machine to eject the casting using a built-in ejection plate. A 300-lb. pot with 500 lb. per hr. melting is the metal capacity.

The angular metal injection assembly is easily removed and is fitted with nitralloy piston and renewable sleeve. The machine is furnished complete with motor, hydraulic oil, pyrometer control, gas equipment and a built-in hydraulic valve with adjustable cam core pulls.



This die casting machine is designed so that it cannot be shot when the dies are open.

Stainless Steels EXCLUSIVELY!



Nation-wide Distribution

G. O. CARLSON, INC., is a dependable source for Stainless Steel in almost every form. We can supply stainless steel of various gauges in a wide range of sizes including "The World's Largest Stainless Steel Plates." Available from 3/16" through 1-1/2", cut to your specific requirements at standard mill prices for patterns shipped.

We can also supply tube sheet discs, sheared or machined from plate, or forged . . . rings, small pieces, odd section bars—all cut to your order.

CARLSON ENGINEERS are at your service to help with any job involving stainless steel products.

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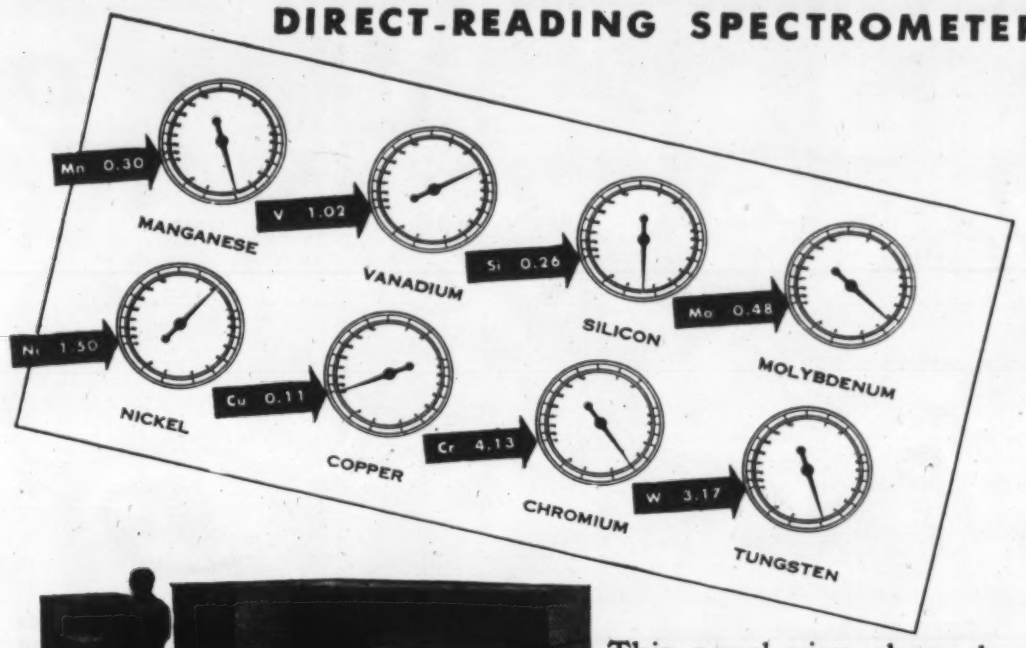
SPECTROCHEMICAL ANALYSIS

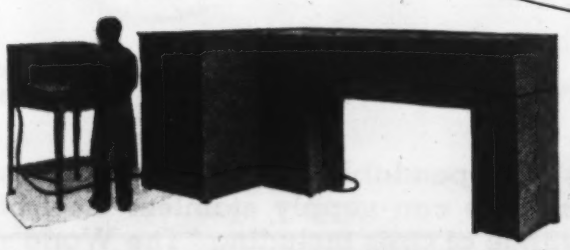
SPEEDED . . . simultaneous determination of eight constituents obtained in 40 seconds

SIMPLIFIED . . . analysis completely made by a single technician

MECHANIZED . . . line intensities automatically indicated on large, easily read dials

with the Baird Associates-Dow
DIRECT-READING SPECTROMETER





This panel view shows how easily determination is indicated for constituents in a typical steel analysis.

Production control analysis, for the desired constituents, is obtained within 40 seconds after the operator has pushed the button that initiates the automatic analyzing cycle. The analysis requires no photographic darkroom, no specialized operating techniques, and no reading of graphs.

Precision of analytical determinations is equal or superior to that of present photographic means using conventional spectrographs.

The operating principle of the direct reading spectrometer involves spectral measurement of a spark or arc struck between two electrodes. The intensity of individual spectrum lines is measured with respect to standard lines by photomultiplier tubes; and the output of these tubes, suitably amplified, is used to trigger circuits that control indicating timers calibrated directly in concentration units.

Other special apparatus produced by Baird Associates, Inc. over the past decade include spectrographs, spectrographic power sources, density balances, infra-red spectrophotometers, microphotometers, infra-red gas analyzers, and Rayleigh interferometers.

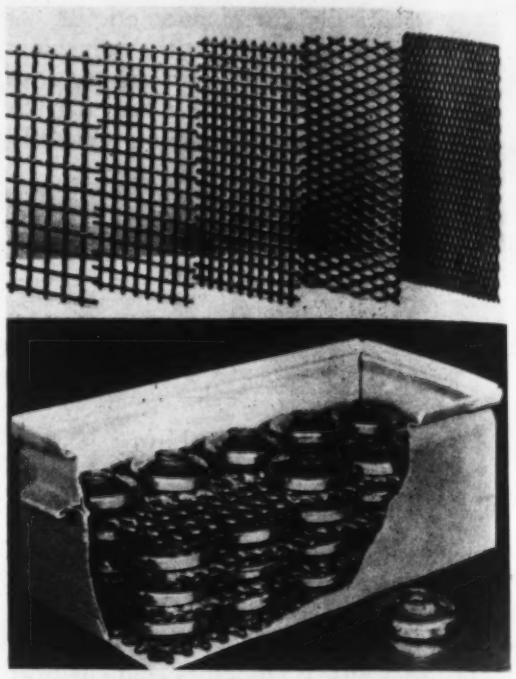
Baird Associates-Dow Direct-Reading Spectrometer offers the advantages of faster control analyses and restoration of skilled laboratory staffs to other functions. For detailed information, request Bulletin 26.

Baird Associates, Inc.
INDUSTRIAL PHYSICISTS
UNIVERSITY ROAD CAMBRIDGE 38, MASS.

Material Handling Separators Are Rubber Covered

Woven wire screen and expanded or perforated metal in all mesh and sizes, completely covered with rubber, are available from *Automotive Rubber Co., Inc.*, 8619 Epworth Blvd., Detroit 4.

Purpose of the screens is primarily to protect by rubber cushion parts which have been plated, painted or precision finished so they will not become scratched, marred



The rubber covered separators being used to handle plated parts.

or disfigured by contact with metal surfaces. The mesh separators likewise permit drainage.

Any size separators can be furnished to fit bottoms of tote pans, conveyor baskets or pallets and can be covered with hard, semi-hard or soft natural rubber or synthetic rubber to meet specific conditions encountered.

Such screens have also been used successfully in trials as separators in palletizing and stacking parts. In these applications, it has been found that rack tipping and skidding of the tiers is materially reduced.

Seam Welder Has Electronic Controls

An electronic automatic welding machine that is said to provide faster welding with less passes per seam is being manufactured by *Niagara Machine & Tool Works*, Northland Ave., Buffalo, N. Y. Variable speed along a track is made possible by the electronic control; thus the length of welding is governed only by the track length. Welds perpendicular to track are made by moving the welding head along the cantilever beam at a variable speed. The power elevated beam can be moved to any height position by push-button control.

High-Speed Press and a Vacuum Press

A new 150-ton plunger type press for transfer molding is offered by the *F. J. Stokes Machine Co.*, Philadelphia 20. The plunger cylinder is mounted on the head of the press and single motor provides power to two pumping units, for actuating the toggle lock and applying ram pressure, respectively. The speed of both toggle and plunger ram movements is fast, so that electronically heated preforms may be used to advantage. Pressures may be independently set to suit any particular job.

With this press the method of loading is optional. A preform may be placed in a centering ring of the lower die when open. The die is then closed, with the plunger ram immediately engaging the material from its partially retracted position of the previous cycle. In the alternate method the die is closed empty and a preform, or powder charge, is loaded through the top of the die between the upper bolsters. A touch of a button then brings down the ram. With either method the cycle is automatically controlled by a bar-type controller.

This controller is a mechanical device which trips a series of switches, these in turn timing each press movement. An advantage of this controller is that when the exact cycle has been established for any job the entire mechanism may be locked so that tampering with it is impossible.

F. J. Stokes Machine Co. has also developed a new machine and technique in which compressing is done under vacuum pressures which are varied to meet conditions. This press applies a maximum of 20 tons pressure from above and below, has a die fill of 2⅝ in. and will produce pieces up to 3-in. dia.

Pressure from above is exerted by means of an adjustable eccentric crank and on the lower punch by cam action. A vacuum chamber surrounds the die table, the punches and the feeding device. The feed hopper, with vacuum cover, is attached to the top of the vacuum chamber and a receptacle under vacuum receives the finished parts at the side of the main vacuum chamber. Special stuffing boxes seal the upper and lower plungers where they enter the chamber. The parts receptacle is large enough to hold all pieces produced from one full charge of the hopper.

All the possibilities of this new technique have not been explored. Tests are being conducted on metal powders, carbon mixes, sintered carbides, ceramic tile and other applications for which this new technique seems to offer possibilities.

● New all-petroleum cutting oils have been developed in the laboratories of the *Sun Oil Co.*, 1608 Walnut St., Philadelphia 3. They are made with a new ingredient called Petrofac, which is derived entirely from petroleum, and eliminates the use of animal and vegetable fats. Good results have been reported on both high-speed automatic machines and heavy duty equipment.

- VARIABLE STOCK LENGTHS from 6" to 72"
- VARIABLE STOCK WEIGHTS from 1 lb. to 102 lbs. each
- TEMPERATURE RANGE from 600° F. to 1200° F.
- HEATING TIME from 20 min. to 120 min.
- PRODUCTION— 6400 lbs. per hr.
- FUEL COST— 24¢ per ton

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Greater production . . . lower fuel costs . . . maximum flexibility in rate of heating and length of soaking time—get *all* these in the Hagan Automatic Recirculating Draw Furnace.

This multi-zone furnace has separate heaters, fans and controls for each zone. Automatic temperature control, mechanized conveyor and Hagan forced convection heating all assure a uniform product through a wide range of part sizes and weights.

Check with Hagan for proved furnace dependability and economy.

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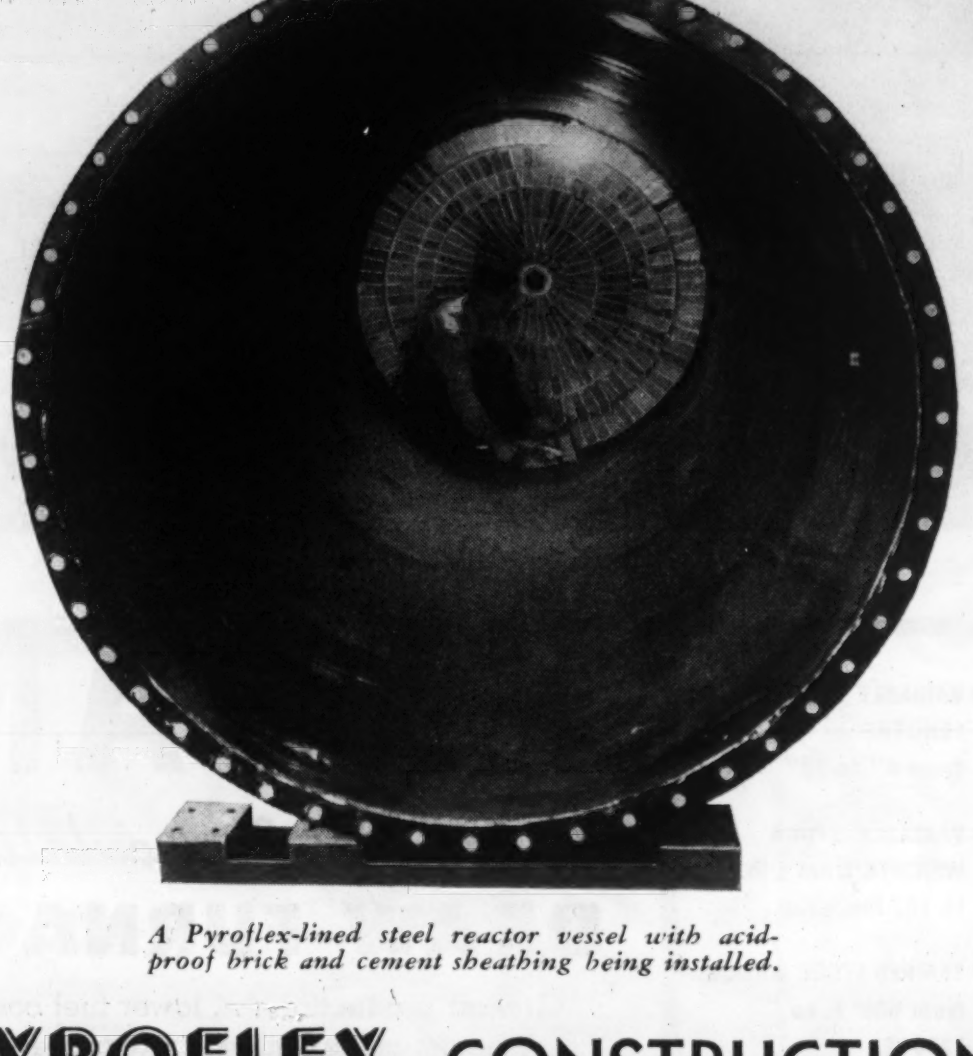


A Pyroflex-lined steel reactor vessel with acid-proof brick and cement sheathing being installed.

PYROFLEX CONSTRUCTION

Means Acid-Proof Functional Equipment

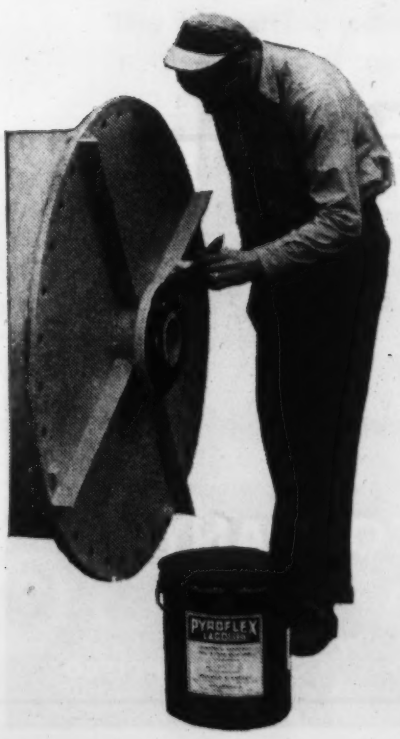
Whether you need fume washers, absorbers, towers, tanks, or other equipment for handling corrosives, Pyroflex constructed functional units will provide you with maximum resistance to corrosive action.

Each unit is designed and built to do a specific job. Engineered with an eye to its operating purpose, the choice of proper materials such as the lining materials, brick, cement, outlets and the method of installation combine to make a unit that will stand up in service.

Pyroflex Functional Equipment is backed by many types of successful installations in various industries. Please give full details when making inquiries.

PYROFLEX PAINT

for Exterior Protection



We use it on the outside of all our Pyroflex-lined steel tanks. Pyroflex lacquer is highly resistant to the action of acids, alkalies and other corrosive agents and may be used on metal, concrete, wood or previously painted surfaces — no primer coat required. Some companies use it on all exterior surfaces subject to corrosive action.

Available from stock in grey, black and white, shipped in 1-, 5- or 50-gallon containers. Red, green, aluminum and clear may be had in minimum lots of 50 gallons. For further details, write

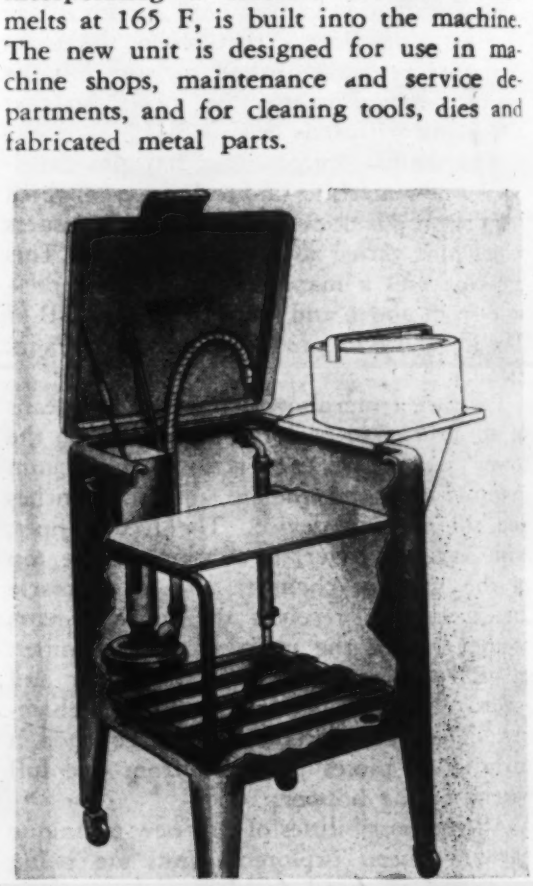
MAURICE A. KNIGHT

7710 Kelly Avenue • Akron 6, Ohio

Industrial Cleaning Machines

A new machine has been developed by the *Mabor Co.*, Clark Township, Rahway, N. J. for the processing of light, small, cup-shaped stampings of comparatively uniform depth. The cycles of the equipment include a washing stage, rinsing stage and a section wherein the parts are dried. The hold-down conveyor can be adjusted to accommodate various types of parts, so that high, continuous production can be achieved. The machine is gas heated by means of immersion combustion burners, although any heating method can be utilized. Any one of the three processing stages can be eliminated or additional processing stages may be added in order to bring parts nearer the point where they can be used for assembly.

A new parts cleaning system has been announced by *Gray-Mills Corp.*, Evanston, Ill. The unit measures 21 in. square with an overall height of 34 in. It has a solvent capacity of 24 gal. The unit uses cold solvent. A work shelf to accommodate parts being cleaned is built inside the tank. This shelf slides out of the way to make the entire tank area available for soaking larger parts under air-agitation. A safety device incorporating a fuseable fire-link which melts at 165 F, is built into the machine. The new unit is designed for use in machine shops, maintenance and service departments, and for cleaning tools, dies and fabricated metal parts.



This small parts cleaning system has a high volume centrifugal pumping unit for flushing out recesses.

A small parts cleaning machine is also being offered by the *L & R Manufacturing Co.*, Arlington, N. J. for the processing of instruments and small metal parts too difficult to handle manually or in any other type of equipment. The work basket measures 3⅜ in. deep by 5½ in. in dia. into which the triple nesting baskets fit so that three sets of parts can be cleaned at one time without the danger of their becoming mixed. The unit is also furnished with controlled reversing action. Aluminum cups under the jars assure more protection for the pyrex containers and perfect alignment with the basket.

Welder Designed for Inert-Arc Welding

A new alternating-current welding transformer (type WP 220-440-v.) designed specifically for use with the inert-arc welding process has been announced by the *Electric Welding Div., General Electric Co.*, Schenectady, N. Y. While especially suitable for welding aluminum, magnesium, and beryllium copper in an atmosphere of argon gas without the use of flux, the new welder may also be used to weld a wide range of other metals and alloys. It is suitable for both manual and machine operation.

Built into a single unit are welding transformer, control panel, capacitors for power-factor correction, a bank of series capacitors to stabilize the arc, a pilot spark circuit for arc starting, and water and gas solenoid valves. The entire assembly is enclosed in a drip-proof case, with electrical terminals and gas and water connections brought out to convenient outlets.

● A new development that is said to make the handling of die sets easier, safer and faster, has been announced by *Superior Steel Products Corp.*, 2754 S. 19th St., Milwaukee, Wis. The die sets, have the bottom grooved, a departure from the flat under surface now in general use. On small sets that can be lifted by hand, the operator inserts his fingers in the grooves instead of sliding the set to the edge of the bed and tilting it. With larger sets, lifting hooks lock into the grooves.

New Carburizing Steels for Heavy Duty Applications

A new series of four improved carburizing steels under the name U. S. S. Super-Kore has been announced by *Carnegie-Illinois Steel Corp.*, Pittsburgh, to meet requirements for deep hardening steels which can be easily processed and machined into airplane, truck, bus and other gears, shafts and pinions subject to heavy-duty service. They are said to show hardenability equal to or greater than more highly alloyed grades now in common use and thereby maintain the desired high core strength and develop the toughness necessary for heavy-duty applications. In addition, these new steels have improved carburizing characteristics, are easier to anneal, and possess substantially improved machinability, which still further reduce ultimate costs.

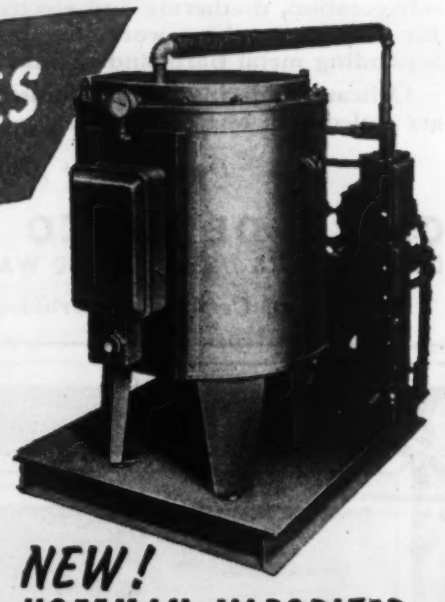
The steels are available in bars, blooms and billets without restriction as to size. There are four grades as follows: "A", recommended where 3310 or 9310 aircraft quality steel is now used; "AA", recommended where 3316 or 9315 is now used; "B", recommended where 4815 or 4820 is now used; "C", recommended where 4317 or 4320 is now used.

NOW Continuous 100% Reconditioning of Industrial Oils...

Oil of uniform clarity is delivered continuously by these two, new Hoffman units. Soluble impurities—such as air, water, gas and fuel dilution—are removed in the Hoffman VAPORIZER. And *insoluble* impurities including oxidized hydrocarbons, are filtered out in the Hoffman CARTRIDGE FILTER. Together, these two units give you complete reconditioning of oil for better, lower cost production.

FOR Removing SOLUBLES

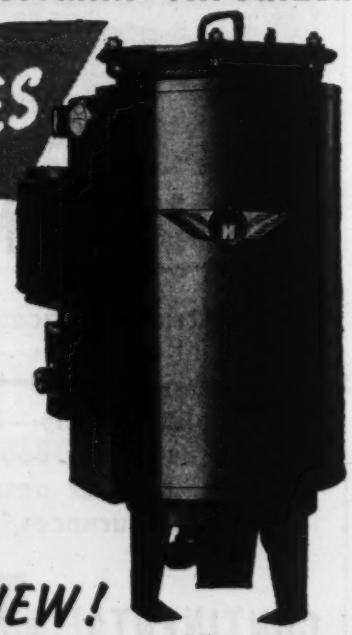
A compact unit (portable, if desired) that passes oil over trays, induction-heated by electricity and under vacuum, to drive off fuel dilution, water, air and gas from any straight mineral, compounded or synthetic oil. ONLY TWO MOVING PARTS...no steam or water connections. Top flow rates.



NEW! HOFFMAN VAPORIZER

FOR Removing INSOLUBLES

The I-1118 series of Hoffman Cartridge Filters is available in cartridge multiples of 1, 2, 3, 4, 6 and 8. Unique design and arrangement of filter element (using repackable or throwaway cartridges) provides a simple, efficient means of filtration. Available with or without heaters and controls to meet service conditions.



NEW! HOFFMAN CARTRIDGE FILTER

WRITE TODAY FOR LITERATURE ON THESE AND OTHER HOFFMAN FILTRATION EQUIPMENT

U. S. HOFFMAN MACHINERY CORPORATION
223 Lamson St., Syracuse, N. Y.
COOLANT FILTERS • FILTRATION ENGINEERING SERVICE

REQUIRE A VACUUM TIGHT JOINT BETWEEN GLASS AND METAL TUBING?

Cerroseal-35 will do the job quickly and permit taking apart easily.

The procedure: tin inside of metal tubing to depth of joint, using any flux. Wash off all flux. Tin outside of glass tubing by wiping molten alloy on tubing, which has been warmed to alloy's melting point, about 244° F. Warm both parts to be joined to give an appearance of wetness and insert glass tube into metal tube. Flow excess alloy into joint to completely fill space and allow to cool. Recommended alloy film thickness—.002" to .004".

Cerroseal-35 is one of a series of interesting and useful Indium alloys having very low melting temperatures.

They are:	Melting Temperature
Cerrolow-105	*105°F
" -117	117°F
" -136	136°F
" -147	*147°F
" -174	174°F
Cerroseal- 35	*244°F
" - 25	*294°F

*Non-eutectic alloys—yield temperatures are those given.

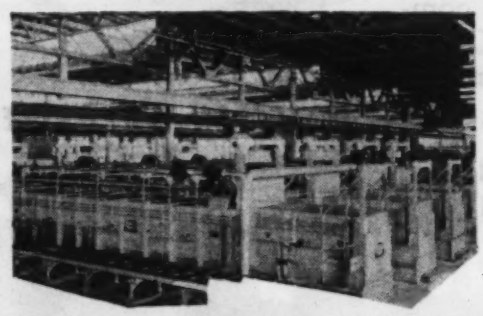
Suggested and actual uses: Fusible links in automatic fire alarm and extinguisher devices; in manual reset thermal switches for controlling processing; or for signalling rise of temperature, as in bearings; thermal safety controls in refrigeration, diathermy and electronic equipment. As a proof casting medium for delicate machine work, Cerrolow-117 can be poured without fear of over expanding metal parts and shrinks but .0002" per inch after casting.

Delicate soldering in small instruments will not be disturbed if dial covers are sealed with one of these low temperature melting alloys.

Describe your problem. Perhaps we can help.

CERRO DE PASCO COPPER CORPORATION
DEPARTMENT 8 — 40 WALL STREET — NEW YORK 5, N. Y.

Makers of Cerrobase, Cerrobend, Cerromatrix, Cerrosafe and Cerrotru.



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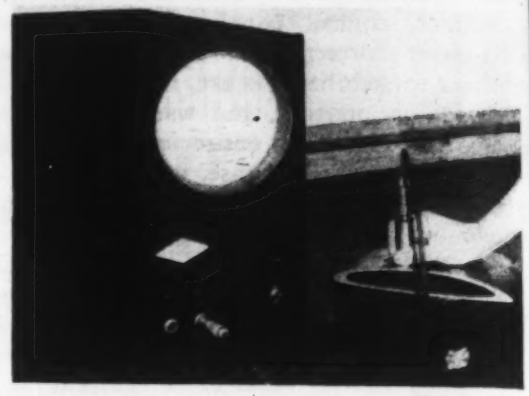
Supersonic Device Measures Thickness of Materials

A new instrument, the Reflectogage, utilizing supersonics for thickness measurement and flaw detection and supplementing the Reflectoscope and the Thruray, has been introduced by *Sperry Products, Inc.*, Hoboken, N. J. With the new instrument thickness of metals and other materials can be measured where access from only one side is available. Maximum error in measurement is less than 2% of the thickness of the material.

Thickness of tubing and flat parts, between 0.005 and 0.300 in., can be read



This supersonic inspection device is adaptable for production line testing of thin pieces.

directly from the face of the oscilloscope screen. Indirect reading of the thickness of parts up to 4 in. can be accomplished with slight calculation.

To operate, a quartz crystal searching unit is applied to the oiled surface of the material and the oscilloscope pattern observed by the operator. The position of the vertical deflection along the horizontal axis is determined by the resonant frequency and is thus related to thickness. When thin pieces are being tested, this thickness is read directly from the superimposed calibrated screen. A different screen is used for each type of material and for each of four thickness ranges.

The instrument is likewise readily adaptable for the production line testing of thin pieces, or bonded or clad materials, for internal defects or separations.

Cold Treating Unit for Small Shops

A new model cold treating machine is being produced by *Super-Treat, Inc.*, 3400 Beekman St., Cincinnati 23, Ohio. This machine is designed to meet the requirements of small and medium size tool shops as well as research laboratories.

The cold chamber size is 10-in. dia. by 24-in. depth and can be cooled from room temperatures to minus 130 F in 1½ hr.

The equipment features operating economically, compact design and low initial cost. The machine is especially suitable for companies that do not require continuous operation. The manufacturers recommended it for stabilization of gages, shrink-fitting, and completion of austenitic transformation in heat treated steel or castings.

lectric Furnace Has 300 to 2000 F Temperature Range

An electric furnace capable of continuous peration at 2000 F, and said to provide ccurate temperature control down to 300 is being built by the *Cooley Electric Mfg. orp.*, Indianapolis, Ind.

It is suitable for heat treating of small arts, tools and dies. It heats from cold 2000 F in 1½ hr. The chamber is 8 by by 14 in. and has six embedded-type eating elements, including one in the door. he power capacity is 4650 watts.

The furnace, Model VK-5, is equipped ith a selective power modifier. Power input ay be adjusted to balance furnace heat osses, and low temperature overshooting of he pyrometer is eliminated. The modifier lso prevents the furnace from running to estructive temperatures in the event of yrometer failure.

The maximum temperature of the furace makes it suited for heat treating of tainless and air hardening steels, which ave hardening temperatures well above

Because of its wide temperature range this electric furnace has many uses for heat treating small parts.

those normally employed for heat treating alloy and carbon steels. It may be used efficiently for normalizing, annealing, carburizing and hardening in the range from 1200 to 2000 F. At the same time, the attainable low temperature of 300 F makes it useful for tempering steel, heat treating nonferrous metals such as aluminum and beryllium copper, and the other low temperature work.

● Two new electrodes which will be known as Agile Brown and Agile Red-White have been announced by *American Agile Corp.*, 5808 Hough Ave., Cleveland 3. Agile Brown electrodes were primarily designed for the all-position welding of thin gage steels with d.c. (straight polarity) or with a.c. currents. They meet requirements of AWS Specification, Class E-6013. Agile Red-White electrodes were designed for all-position welding of mild steel at highest speeds. They meet the requirements of AWS Class E-6012 and operate on d.c. (straight polarity) or a.c.

An Announcement

THE Ajax Engineering Corporation is pleased to announce that it has acquired the exclusive license from the Scomet Engineering Company for the manufacture and sale of high-capacity, low-frequency induction furnaces.

These Ajax-Scomet Furnaces, having an input of from 500 to 2,000 kw, are ideally suited for the production of oxygen-free high conductivity copper and other metals of high quality. They can be used for melting tough pitch and phosphorized copper, copper alloys, aluminum and aluminum alloys and electrolytic zinc, and can be operated intermittently or continuously.

Information furnished on request.

AJAX ENGINEERING CORPORATION

Trenton 7, New Jersey

Associate Companies

AJAX METAL COMPANY, Non Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORP., Ajax Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax-Wyatt Induction Furnaces for Melting

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:**

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

The accepted melting tool in brass rolling mills throughout the world.

AJAX ELECTRIC FURNACE CORP.
1108 Frankford Avenue
PHILADELPHIA 25, PA.

*** UPWARDS OF 5 BILLION POUNDS ANNUALLY**

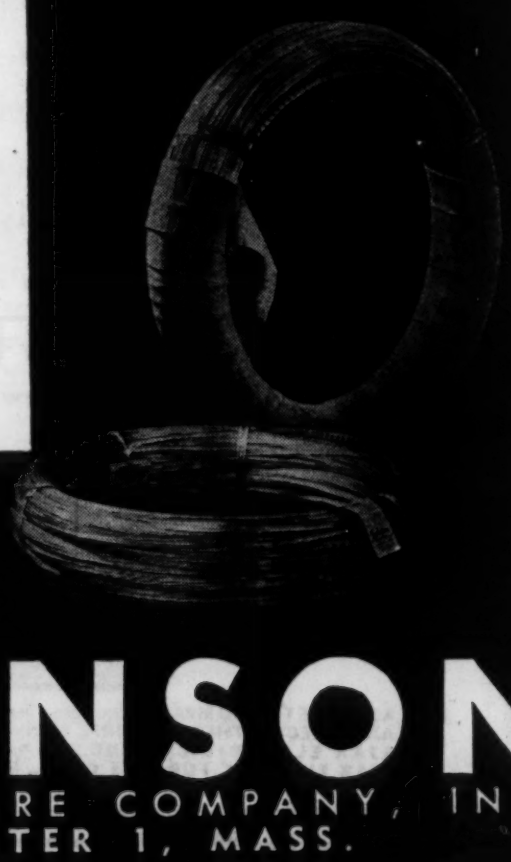
THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Holtgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

The Wire of a Thousand Uses

JOHNSON XLO MUSIC SPRING WIRE gives you maximum tensile strength, absolute uniformity of all physical properties now available with special corrosion resistant coating. Johnson special alloy coating has definite lubricating qualities, reducing tool wear, perfect base for soldering or plating. Withstands 700° Fahrenheit. Sizes .003" to .080".

Your nearest Johnson branch will give you prompt service.

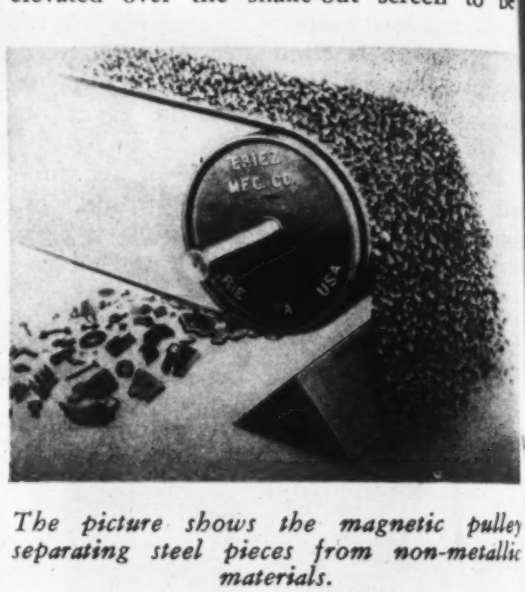


JOHNSON
STEEL AND WIRE COMPANY, INC.
WORCESTER 1, MASS.
NEW YORK AKRON DETROIT CHICAGO LOS ANGELES TORONTO

Magnetic Pulley Uses Permanent Magnets

A completely self-energized magnetic pulley requiring no electric current to generate a magnetic field is now being produced by the *Eriez Manufacturing Co.*, 2694 E. 12th St., Erie, Pa. The pulley is adaptable to all applications requiring automatic separation of magnetic from non-magnetic materials conveyed on a belt. It is powered by large Alnico magnets.

The equipment can be used in conjunction with foundry mold shake-out machines. The pulley removes iron fins, particles and gaggers from the sand as it is elevated over the shake-out screen to be conditioned for reuse. For the metal working industry, this magnetized pulley brings about separation of ferrous from nonferrous borings, turnings, etc. Since no wiring is required, portable magnetic separation can be made at several points in a plant with the same unit. It can be used for separating steel working pieces from quartz, stones and other non-magnetic materials following tumbling operations by running both materials over a magnetic pulley.



The picture shows the magnetic pulley separating steel pieces from non-metallic materials.

Bright Dipping Solution for Copper Alloys

A new solution for bright dipping of copper and copper alloys has been introduced by the *Rossaul Co.*, 119 W. 63rd St., New York 23. Known as Copperbrite, the solution removes oxides, leaves metal bright and resistant to future tarnish or discoloration. Metal is left passivated and ready for the next operation.

The solution is non-toxic, non-fuming and safe for the worker to handle. It has applications in the manufacture of gold plated jewelry, locks, bronze doors, brass fittings and similar goods. It will not discolor silver solder.

Used at room temperature in acid resistant still tanks, it requires only a dip and clear water rinse. Five sec. immersion are required for a bright dip; three min. for removal of heat scale.

1500-Ton Hydraulic Press Has Push-Button Control

A new 1500-ton straight side hydraulic press has been constructed by the *Verson Allsteel Press Co.*, Chicago. Standing 38 ft. high, the new press measures over 19 ft. in length and 10 ft. in width. The stroke is 48 in. with 88¾ in. of daylight. Bed area is 96 by 144 in. Total weight is approximately 500,000 lb.

From an engineering standpoint, the press features fast advance to the work with automatic shift to full pressure stroke, eliminating high-speed impact. Reversal is automatic on pressure or distance. Electrical push-button control is provided for automatic operation with control stations for four operators.

The first press of this type completed will be used in the forming of heavy parts for tractors. It is equipped with cushions in the bed, having a capacity of 500 tons and a stroke of 24 in. The die set alone weighs 74,000 lb.

● Silver-molybdenum electrical contacts said to have good arc resisting characteristics are now being manufactured by *Gibson Electric Co.*, 8356 Frankstown Ave., Pittsburgh 21. At present, the new contact material is supplied in two grades: Gibsiloy M-10 and Gibsiloy M-12, the latter containing a higher percentage of molybdenum. Because of its higher refractory content, Gibsiloy M-12 is used on heavy circuit breakers where greater mechanical and electrical stresses are encountered. Gibsiloy M-10 is used on smaller size circuit breakers handling lower pressures.

Water-Shedding Liquid Dries Metals

A new product, called "Hydrex," a water displacing liquid, has been announced by *Enthone, Inc.*, Dept. MA, 442 Elm St., New Haven, Conn. It is a thin mobile liquid that sheds water from the surfaces of metals. It has high penetrating power to enable it to displace water from blind holes and crevices. After the water has been displaced the work is removed from the liquid and the solvent evaporates, leaving a water-free surface with some rust-inhibiting properties.

The liquid can be used for drying of plated work to prevent staining such as chromium plate, silver plate or cadmium. Spots that normally remain on the work from solids dissolved in the water, such as chromic acid or from the normal solids present in hard water, are removed. The water separates to the bottom of the liquid and can be drawn off periodically.

It can also be used for drying of steel after pickling and is particularly valuable for drying in the presence of high humidity when rusting occurs. Two types are available: No. 1 which has a flash point of 100 F; No. 2 which has a flash point of 150 F.

ACCURACY

with

ENGELHARD PORTABLE INDICATING PYROMETERS

Engelhard Portable Indicating Pyrometers combine the necessary attributes of accuracy which distinguish precision instruments.

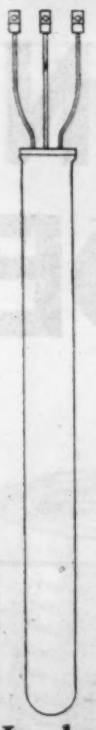
High resistance per millivolt assures a degree of accuracy unaffected by connecting lead length or by thermocouples of different resistances. The 6" scale length indicator may be calibrated with 100 to 150 divisions. Every indicator is equipped with the Englehard frictionless moving coil.

All indicators may be furnished with two scale calibrations—for rare metal and base metal thermocouples.

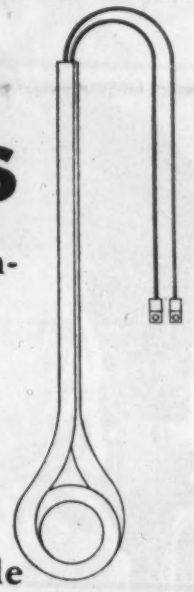
• *WRITE FOR BULLETIN 400* •

CHARLES ENGELHARD, INCORPORATED

900 Passaic Ave. • East Newark, N. J.



NEW DESIGNS FOR IMMERSION HEATERS



Amersil's* research has produced a new immersion heater which can be:

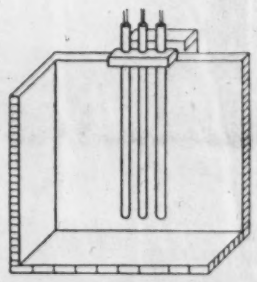
Quickly and easily installed.

Occupies less space than conventional types.

Offers a minimum of obstruction.

Provides greater radiating surface with multiple units than with a single large unit.

Will not contaminate the product.



Is chemically resistant to boiling concentrated acids. *(Not resistant to Hydrofluoric acid or alkalies)*

Write for the new Amersil Catalog for more complete details.

*Trade Name Registered

AMERSIL COMPANY Inc.

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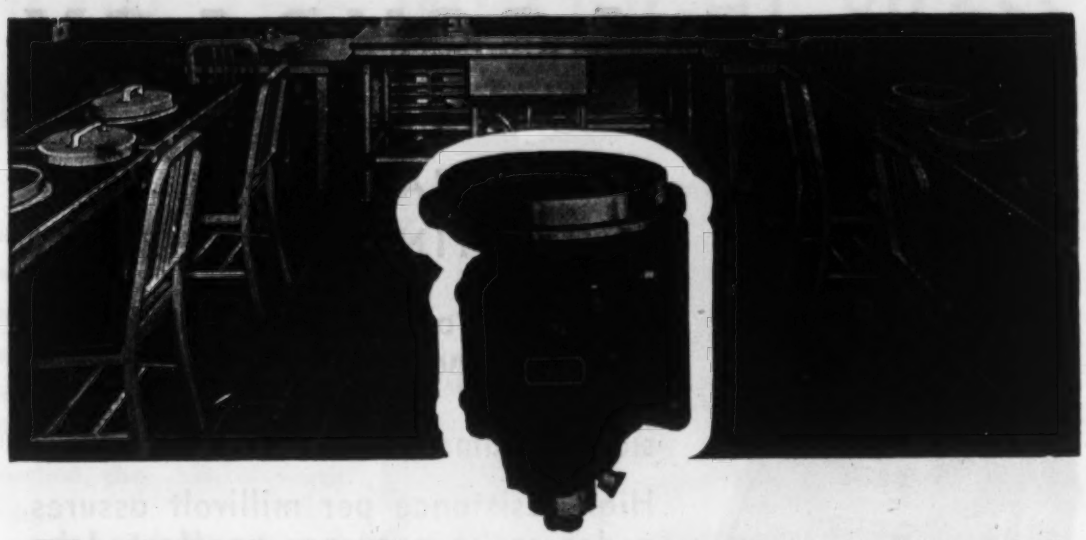

The Cincinnati METALLOGRAPHIC POLISHING MACHINE
produces SCRATCH-FREE SPECIMENS EVERY TIME!

Features

- No belts, no friction drive — direct-connected.
- No excessive noise or vibration.
- No splashing of polishing materials.
- Bronze bowl, disk and ring resist corrosion.
- Ball bearing throughout.
- Easy to clean.

The Cincinnati Variable Speed Polishing Machine sets a new standard of efficiency for smoothness and simplicity of operation in the preparation of specimens for microscopic examination . . . uniformity and scratch-free surfaces are achieved consistently — even with inexperienced operators — because of the smooth running, direct connected, variable speed motor which gives a range of speeds between 300 and 3,000 R.P.M. Write for Bulletin S9 for full descriptive details.

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Master Hands on Intricate Jobs use
SHAWINIGAN CARBIDE

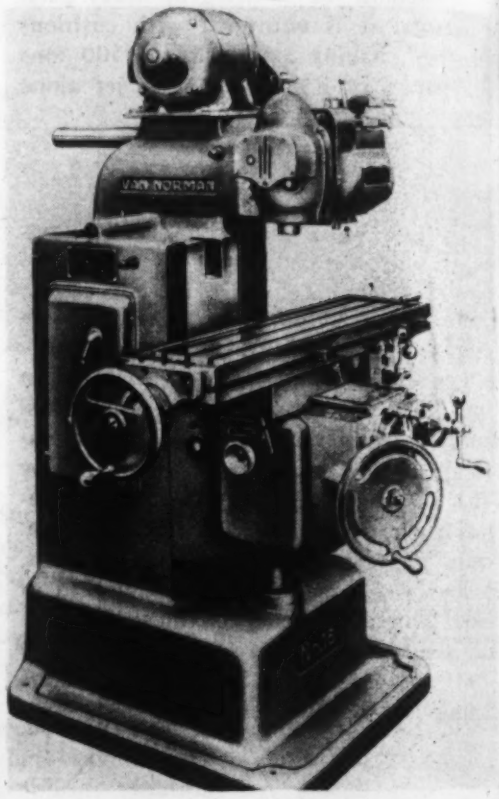
SHAWINIGAN PRODUCTS CORPORATION
EMPIRE STATE BUILDING,
NEW YORK 1, N.Y.

Ram Type Machine for General Purpose Work

A new ram type milling machine, Model No. 16, applicable for the tool room, pattern shop, die and mold shop, experimental laboratory, repair shop and general purpose milling, has been announced by the *Van Norman Co.*, Springfield, Mass.

This machine features an adjustable cutter head and movable ram which permits horizontal, vertical as well as angular milling, with standard milling cutters and conventional milling practices. The movable ram in combination with the saddle and knee adjustment increases the versatility and work range of the miller.

Power feed is provided for table longitudinal travel. Table feeds and spindle speeds



The ram type milling machine shown here has precision ground feed screws.

are controlled by levers which provide for nine feeds ranging from 0.6 in. per min. to 16 in. per min. Nine spindle speeds from 95 to 2000 rpm. are selected by two levers.

Hand wheels are provided to give cross feed, vertical feed as well as table adjustments. Dials are graduated in thousandths. Specifications include: table size 37 by 9½ in.; table travel (power) 18 in.; saddle cross feed (hand) 8 in.; knee vertical feed (hand) 17 in.

● The *Bee Chemical Co.*, 63 E. Lake St., Chicago, has developed a grinding coolant which has been named Wheelyfe 85. It is a clear solution which will not load the wheel even with the finest grit sizes. Because of freedom from loading, the finish is determined by the grit size used and is not the mirror finish obtained by the buffing action of a loaded wheel.

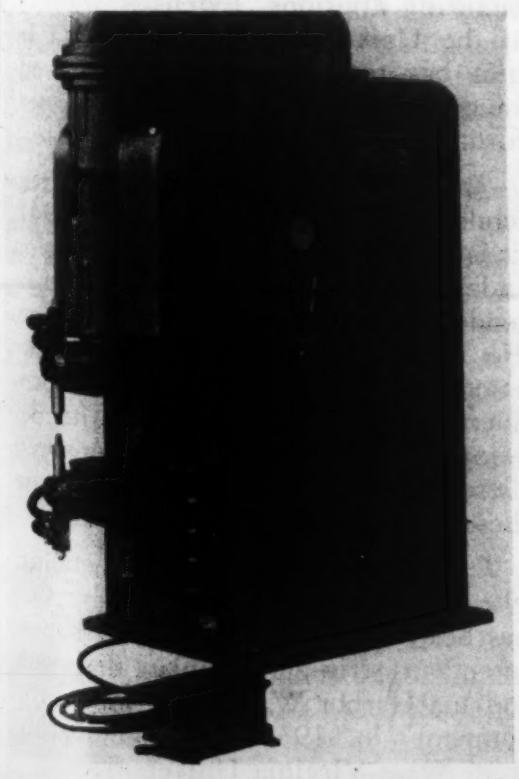
A new 10 ton foot-operated hydraulic arbor press for machine shops, tool rooms, and garages for press fitting, staking, assembly, riveting, crimping, etc. has been announced by *Air-Hydraulics, Inc.*, 401 Broadway, New York 13. The pressure is entirely hydraulically controlled by a foot-pump unit which leaves the hands free to handle and position the work. Each stroke of the center pedal moves the ram 7/8 in. down to work. The right pedal or power pump moves the ram down 1/16 in. with each stroke. A touch of the left pedal and the ram returns to its original position.

Spot and Projection Welder Designed for General Purpose Use

A new general purpose air-operated bench-type combination spot and projection welder for welding mild steel, stainless steel, aluminum, etc., has been announced by the *Federal Machine & Welder Co.*, 10 Dana St., Warren, Ohio.

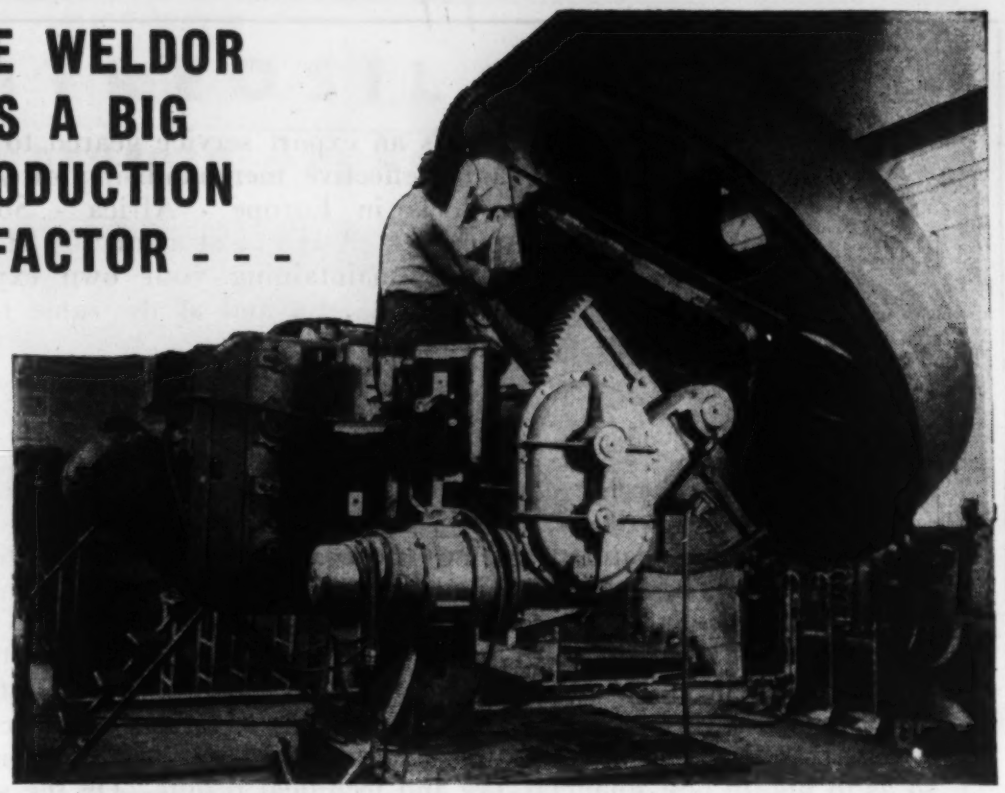
The machine is equipped with a low-inertia rubber head with micro-switch firing. The vertically adjustable lower knee is standard as are the horns and water-cooled point holders. The 30 kva. transformer, contained within the frame, has six steps of heat regulation which are controlled by the tap switch arrangement. The plug-in type foot operating switch leaves the operator's hands free to handle the material being welded.

The 2¼ in. stroke of the machine is actuated by an air-operated double-acting cylinder. Throat depth from the machine face to the center line of the electrodes is 6 in.; from the machine face to the center of platens, 4½ in.



While this combination spot and projection welder follows conventional lines, it incorporates several improvements.

THE WELDOR IS A BIG PRODUCTION FACTOR - - -



Your welders are *big* production factors when they work with C-F Welding Positioners because these power operated Positioners with variable speed table rotation are real production tools. Better automatic welding is possible because the C-F Variable Speed feature governs table rotation speed from 0 r.p.m. and up—assuring better control of fillet in circular or peripheral automatic welding.

If increased production, better downhand welding and lower costs in your welding department can help you meet the competition for new markets, C-F hand and/or power operated welding positioners should be your first choice. Write for Bulletin WP 22.

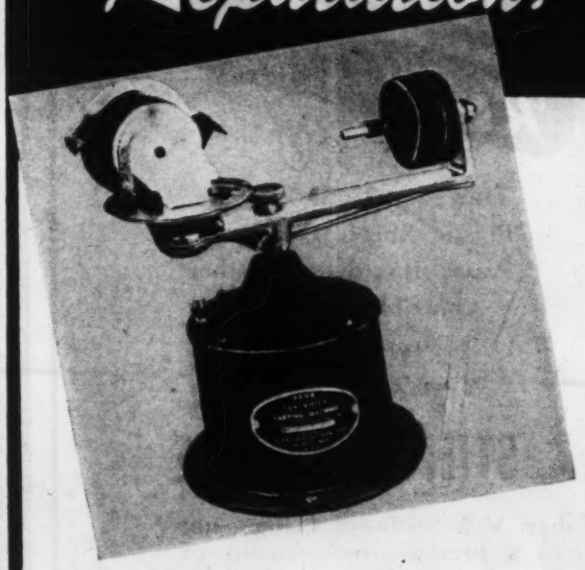
CULLEN-FRIESTEDT, CHICAGO 23, ILL.

C-F positioned welds mean better, more economical welds

The **KERR CENTRIFICO**

CENTRIFUGAL CASTING MACHINE

Reputation: **TOPS!**



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Standard for many years in the dental, jewelry and industrial fields, the "CENTRIFICO" has *earned* its reputation. This sturdy unit mounts an arm, jointed at the crucible end to minimize spillage. The standard arm takes flasks up to 3½" x 2½" and an auxiliary arm is available for flasks up to 4" x 5½". The "CENTRIFICO" is available as shown, or in an attractive black and grey transite cabinet.

See

the KERR CENTRIFICO in our new catalog, "Precision Casting by the Lost Wax Process" – 32 pages of information, equipment, and "know-how". Send for your *FREE* copy today!

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FREE. This illustrated brochure on stiffness and resilience testing. (Also handbook on wear resistance measurement with the Taber Abraser.)

The Taber V-5 Stiffness Gauge not only gives a precise measurement of stiffness, but also provides a method for testing resilient qualities of materials.

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TABER V-5 STIFFNESS GAUGE

News of...

ENGINEERS COMPANIES SOCIETIES

Engineers

T. W. Allsworth has been made vice president in charge of engineering, Intercontinental Engineers, Inc., Chicago 3, having joined the company in 1946 as chief project engineer. He is a specialist on rolling mills—their design, construction and operation—and has served Aluminum Co. of America, American Rolling Mill Co., Bridgeport Brass Co., and other companies.

F. W. Deck, until recently general manager, Trent Tube Mfg. Co., has been retained by Borg-Warner Corp. as a consultant on manufacturing research. Before the war he was engaged in research and development on steel production and fabrication processes for Union Carbide & Carbon Corp. During the war he was with the Manhattan project at Oak Ridge, Tenn.

David W. Hopkins, consulting engineer, has been promoted to executive vice president, R-S Products Corp., Philadelphia, manufacturing engineers. He will have full administrative authority in the valve, furnace and manufacturing divisions. Extensive research at the University of Pennsylvania by him has resulted in many basic advances in valve construction and performance.

Jack F. Knobloch, general superintendent, Weatherhead Co., since 1941, has joined Jack & Heintz Precision Industries, Inc., Cleveland, as superintendent of the ball bearing division. He has enjoyed 34 years of intimate association with precision machine production. With Ingersoll-Rand he developed the first successful high-speed diesel engine. He also worked on diesels with General Motors Corp.

Earl W. Mahaney, former metallurgist, Youngstown Sheet & Tube Co., has been made assistant general superintendent, strip and tin plate divisions, Indiana Harbor Works. He joined the company in 1936 after graduating from West Virginia University.

Harry R. Fillmore is appointed general foreman, Hornell, N. Y., plant,

News of...

ENGINEERS COMPANIES SOCIETIES

SKF Industries, Inc., a plant scheduled to begin operations Sept. 1 in the manufacture of anti-friction pillow blocks formerly made at the main Philadelphia plant. He had been assistant general foreman of the cast iron department.

Christy J. Vander Volk has been made technical director of the red lead division, Lead Industries Assn., New York 17. He will coordinate the association's research program on metal protective paints and perform technical service to users of red lead. He was formerly with the research department, Heyden Chemical Corp., Garfield, N. J.

Carl H. Samans has been made chief, metallurgical section, research laboratory, American Optical Co., Southbridge, Mass., replacing *W. J. Wrighton,* retired after 27 years in that position.

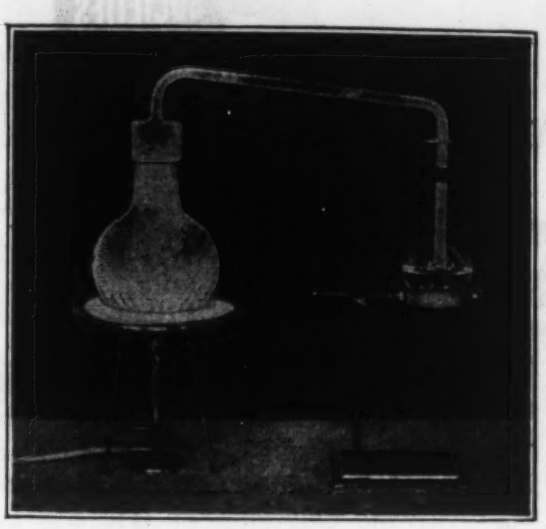
Hugh E. Riordan has joined the staff of Battelle Memorial Institute, Columbus, where he will do research on the engineering properties of materials. He was an engineering officer in the Navy and holds a master's degree in mechanical engineering from Rensselaer Polytechnic Institute.

Dr. *Bruce S. Old* is now consultant to the Atomic Energy Commission, division of research, as chief metallurgist, serving on a part-time leave of absence from Arthur D. Little, Inc., where he has developed a technique for operating pig iron making blast furnaces under pressure, increasing output. He received his doctorate from Massachusetts Institute of Technology in 1938.

Dr. *Bernard Kopelman* has been made section head, metallurgical research group, Sylvania Electric Products, Inc. In 1941 he engaged in research work in the metal, vitreous enamel and glaze fields for the Titanium Alloy Mfg. Co., Niagara Falls, N. Y. He authored a recent scientific paper on factors affecting the particle size of hydrogen-reduced tungsten.

Dr. *John N. Mrgudich,* physicist and research engineer on electrical batteries, has been made research director, electrical divisions, Winchester Repeating Arms Co. and Bond Electric Corp., divisions of Olin Industries, Inc. Dr. Mrgudich has been an educator and is author of 14 technical publications dealing with X-ray diffraction, electron microscopy, spectroscopy and in-

VITREOSIL (Vitreous Silica)
Laboratory Apparatus and Utensils



Conductivity Water Distilling Apparatus

Highly acid-resistant
•
Indifferent to thermal shock
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Constant in weight and volume
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For continuous use up to 1000 - 1100°C.

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5 Special Transparent Ware
10 Standard Transparent Ware
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THE THERMAL SYNDICATE, LTD.
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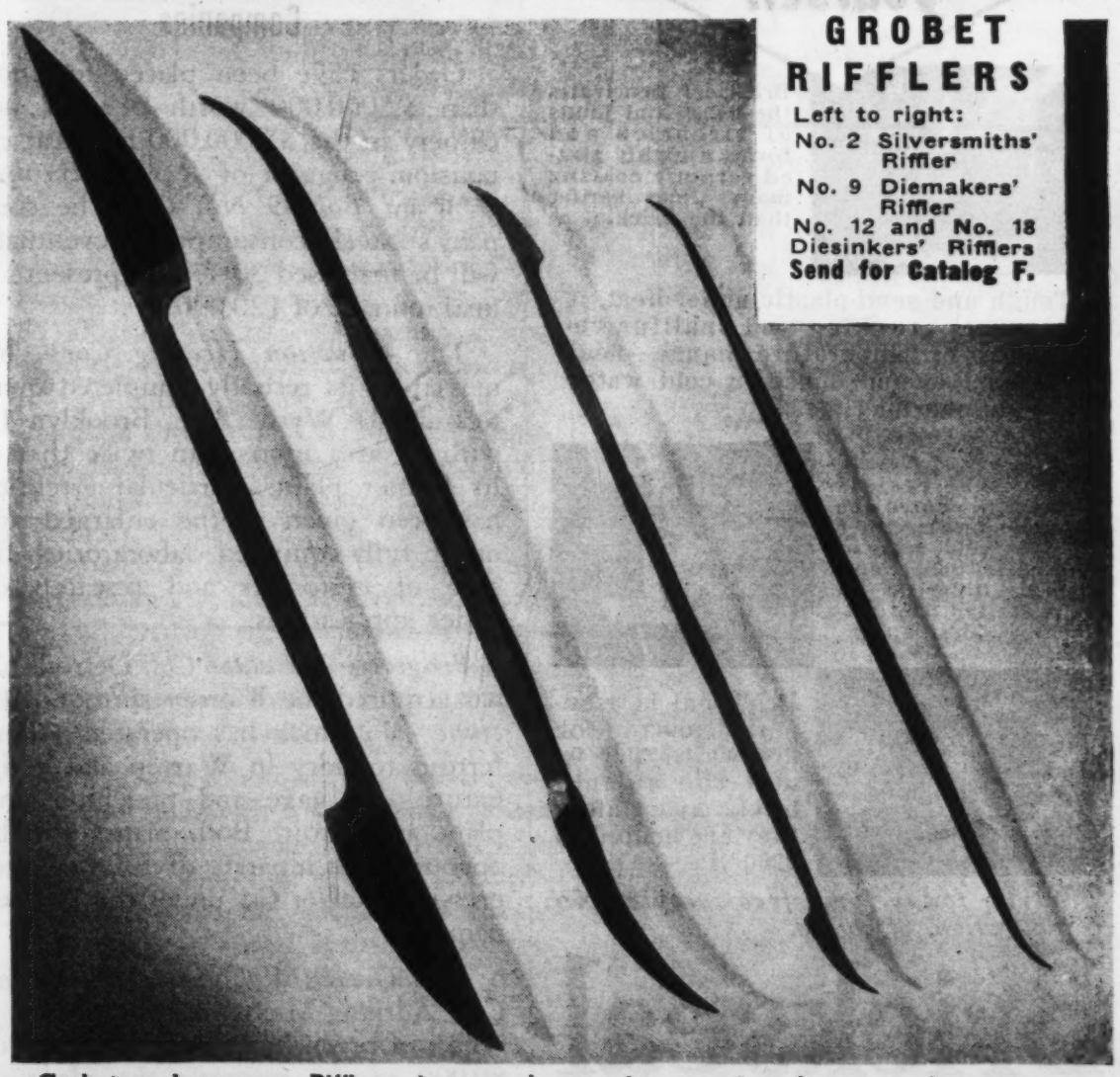
GROBET RIFFLERS
Left to right:
No. 2 Silversmiths' Riffler
No. 9 Diemakers' Riffler
No. 12 and No. 18 Diesinkers' Rifflers
Send for Catalog F.



Grobet produces more Rifflers—in more shapes—in more sizes than any other company. Grobet is the oldest manufacturer of precision files in the world. Try a set for your specific requirements and you'll never change.

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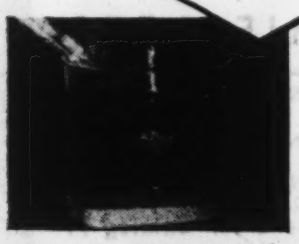
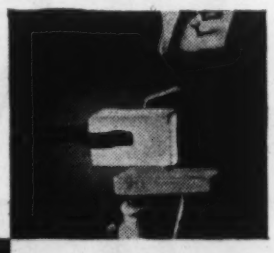
SEND FOR this Brickseal coated BRICK

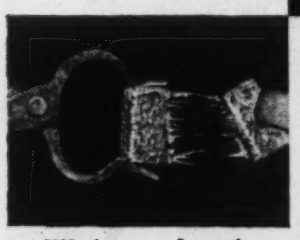


Brickseal penetrates the pores and joints of firebrick and forms a highly glazed ceramic coating many times harder than the brick.

Tough and semi-plastic under heat, it prevents cracking and spalling regardless of temperature change—heat the sample and douse in cold water any number of times.



Brickseal resists abrasion. Force the sample brick, either hot or cold, against an emery wheel and see the difference on the coated and uncoated sides.



Brickseal is a superior mortar for fire walls. Try to pull the sample bricks apart after they are heated to 2200°.

Write today for a free sample. No obligation, of course.

Brickseal

REFRACTORY COATING

5800 So. Hoover Street, Los Angeles, Calif.
158 - 14th Street, Hoboken, New Jersey

News of...

ENGINEERS COMPANIES SOCIETIES

strumental methods applied to storage batteries, dry cells, high tension cables, biologicals and polymers.

Frederick W. Willard, retired president, Nassau Smelting & Refining Co., Inc., died Aug. 11 at his home at Summit, N. J., at the age of 66. Over 40 years with the Bell system, he was a prominent metallurgist and chemical engineer and was active in war work with technical committees sponsored by the Government. He was engaged in work of numerous scientific and technical societies and a contributor to technical journals. For the last four years, he has served as editor-in-chief of the American Chemical Society Monographs. Recently Mr. Willard had served in an advisory capacity for Calumet & Hecla Consolidated Copper Co. He was prominent in the affairs of his community and had a humble and engaging personality.

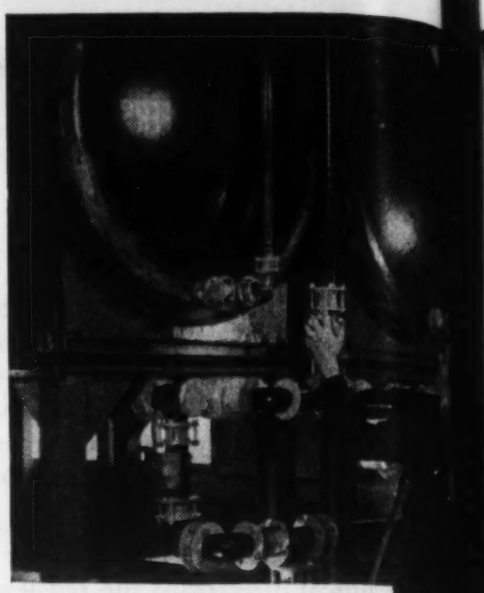
Companies

Orders have been placed for more than $2,000,000 worth of new machinery in the $5,000,000 five-year expansion program of *Russell, Burdsall & Ward Bolt & Nut Co.* The company's steel consumption eventually will be increased 20% over present annual tonnage of 120,000.

The *Induction Heating Corp.* has moved to its recently-completed quarters at 181 Wythe Ave., Brooklyn 11, with an area more than twice that of its former plant. Particular attention has been given to the enlarged and more fully-equipped laboratories for sake of customers and research on wider applications.

Progressive Welder Co., Detroit 12., has acquired the *Warren Alloy & Machine Co.,* which has operated a nonferrous foundry in Warren and a jig, fixture, die, gage and punching unit plant at Detroit. Both plants will be operated as a separate division of Progressive Welder Co. under the Warren name.

The *Gerity-Michigan Die Casting Co.,* Adrian, Mich., has purchased a group of seven buildings, with area of 80,000 sq. ft., formerly the plant of the *Brown Fence & Wire Co.,* that city. The new space will house offices, shipping department and warehouse.



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Process Equipment

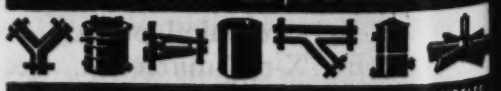
Solid, structural, molded HAVEG insures the long life of chemical equipment because of its resistance to acids and alkalies through its entire mass.

Not being a lining or coating, surface abrasions and scratches cannot destroy or even slightly affect its effectiveness.

HAVEG piping and fittings are stocked in sizes from ½" to 12" I.D. and fume duct from 2" to 36" I.D. Tanks 10' in diameter and 12' high, as well as other equipment, can be made to your specifications at low cost.

Send for Bulletin F- for full data

HAVEG CORPORATION
NEWARK 25, DELAWARE



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2 ACCURACY
3 CRAFTSMANSHIP

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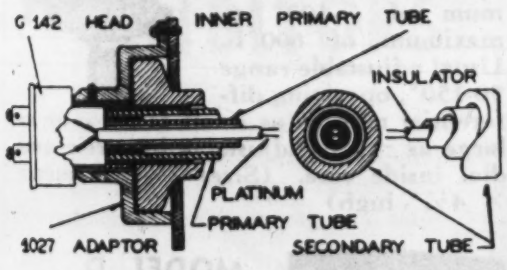
GORDON
Platinum, Platinum-Rhodium
THERMOCOUPLES

Thirty-three years of experience and "know-how" go into the production of Gordon Platinum, Platinum-Rhodium Thermocouples. From this experience has evolved the Gordon policy which calls for the utmost in quality and service, the utmost in value to clients. That is why Gordon platinum wire is carefully checked for thermocouple accuracy against a master thermocouple . . . calibrated and certified by the National Bureau of Standards.

The porcelain insulation and protecting tubes which go into a complete thermocouple assembly are of the finest quality obtainable. They are the best known means of preventing contamination of the elements which result in false e.m.f. values. Also, the Gordon G-142 head which goes into a complete thermocouple assembly is light in weight and permits easy replacement of new elements into a protecting tube assembly.



The Gordon Policy—highest quality and standards of material—plus Gordon craftsmanship at the lowest possible price.

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Specialists for 33 Years in the Heat Treating and Temperature Control Field

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News of... ENGINEERS COMPANIES SOCIETIES

The *Eutectic Welding Alloys Corp.* has opened a new plant at 110 Duane St., New York, where output and research will be centralized.

A new industrial film, "Speed Nut Savings Factor," is obtainable from *Tinnerman Products, Inc.*, 2038 Fulton Rd., Cleveland 13. It is a 17-min., black, 16-mm. movie showing typical speed nut applications to various assembly problems.

The *Bjorksten Research Laboratories*, Chicago 1, have leased from *Edwal Laboratories, Inc.*, 732 S. Federal St., Chicago, laboratory space for research projects for clients. Edwal has transferred some of their research activities to their Ringwood, Ill., plant, continuing other work at the downtown address.

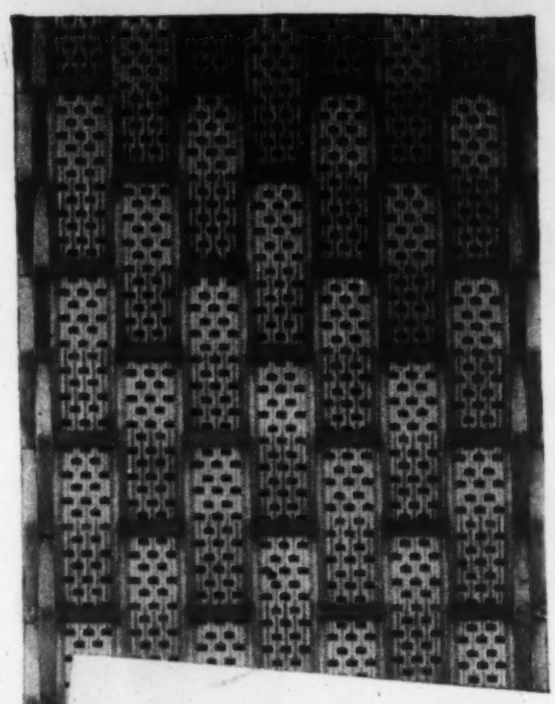
United States Steel Products Co., fabricator of carbon and stainless steel sheets into shipping containers, plans a 32,000 sq. ft. enlargement to its plant near Dolton, Ill. Four new buildings will be added.

The *Rust Furnace Co.* will reconstruct two billet heating furnaces at the Joliet, Ill., works, *American Steel & Wire Co.*; also 12 annealing furnaces at the Indiana Harbor, Ind., mill, *Youngstown Sheet & Tube Co.*

To beat the steel shortage a syndicate of 25 manufacturers has purchased a steel mill at Phoenixville, Pa., for $4,000,000, the mill consisting of six open hearth furnaces and three rolling mills. The syndicate had previously bought a sheet mill at Apollo, Pa. Sheet bars from the Phoenixville mill will be rolled into sheet steel at Apollo, formerly the *Apollo Steel Co.* Among products of syndicate members are kitchen stoves, lawn mowers, furniture and advertising signs. Arnold H. Maremont, 1915 Tribune Tower, Chicago, is syndicate president and the group is known as the *Phoenix-Apollo Steel Co.*

The *Klem Chemical Works* has been incorporated with a new name, *Klem Chemicals, Inc.*, contemporaneous with plant expansion that will double manufacturing capacity. General offices of this maker of metal treating chemicals will remain at 14401 Lanson Ave., Dearborn, Mich.

The *Cyclic Chemical Co.*, Washington, D. C., has formed the Permolite Div. for the manufacture of protective coatings of the chemical resistant type.



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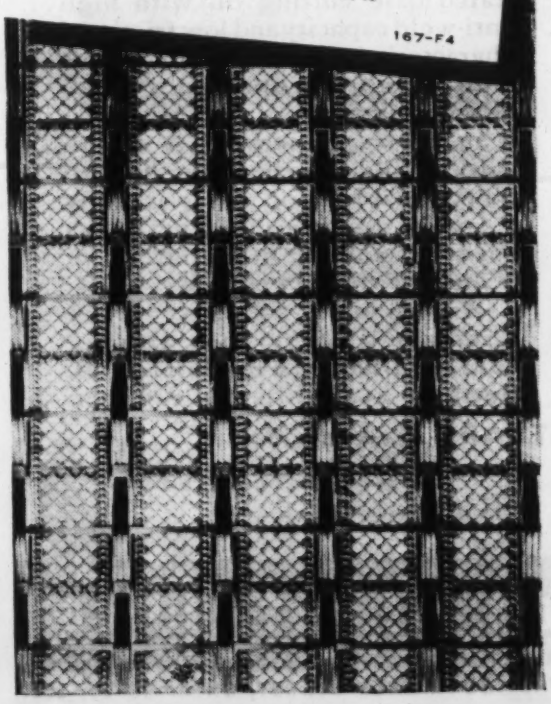
—a new product of woven metal with new possibilities for architects and product designers. Combining strength, beauty and durability, it is extremely flexible and versatile in application.

For complete information, write: *General Electric Co., Electronics Department, Syracuse 1, New York*



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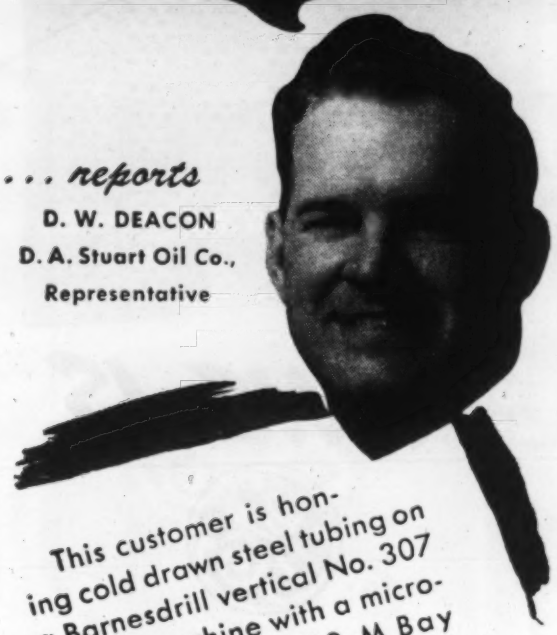
LONGER HONE LIFE
with SUPERKOOL *



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This customer is honing cold drawn steel tubing on a Barnesdrill vertical No. 307 honing machine with a micromatic head. A 120-M Bay State stone removes 30 to 35 thousandths on the I. D. With Stuart's SUPERKOOL* Base mixed 4 to 1 kerosene no tool marks are in evidence. stone life is increased considerably, the finish is excellent and the customer praises SUPERKOOL No. 41* highly.

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. . . Stuart's Superkool is a concentrated base cutting oil with high anti-weld capacity and low frictional characteristics. Its light color affords clear visibility on operations where close gaging or constant inspection is necessary. Superkool is chemically stable, sterile, and has no objectionable odor. These are only a few of the reasons why it has been a standard in hundreds of plants for over twenty-five years.

Ask to have a Stuart Service Engineer discuss your cutting fluid requirements. SUPERKOOL Booklet available on request.

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EST. 1865 LIMITED

2745 SOUTH TROY STREET, CHICAGO 23, ILL.

News of...

ENGINEERS COMPANIES SOCIETIES

Headquarters and plant operations will be in a modern plant at Hamilton, Ohio.

Handy & Harman, producer of silver and gold alloys, has joined forces with Thomas J. Dee & Co., maker of products for the dental, jewelry and chemical trades, the latter company becoming the Dee Div. of Handy & Harman. The Chicago office of Handy & Harman is being moved to the Dee Div. plant at 1900 W. Kenzie St.

The United Aluminum Castings Co. has expanded facilities by moving into its new plant at 3471 W. 140th St., Cleveland 11, where capacity will be increased from 40,000 to 300,000 lb. monthly.

A new corporation for consultation, research and development in powder metallurgy, the *Sintercast Corp. of America,* has been formed by Erwin Loewy, president, *Hydropress, Inc.,* Dr. Claus G. Goetzel, technical author and teacher on the subject, and John Ellis, who has specialized in powder equipment design, production procedure and sales engineering.

The *B & M Manufacturing Co.,* 19 N. Harrison St., Orange, N. J., has been formed by Wiley W. McMinn and Olof Brant, both formerly of *Agaloy Tubing Co.* The company will manufacture in their Michigan factory spirally formed tubular products under name of "Spiralock."

Carborundum Co. has acquired a site for an extensive furnace plant at Vancouver, Wash., where it will erect a silicon carbide furnace plant and facilities for preparation of raw materials, mixing plant and crushing unit. Present is adequate electric power for operation of high temperature furnaces for silicon carbide production.

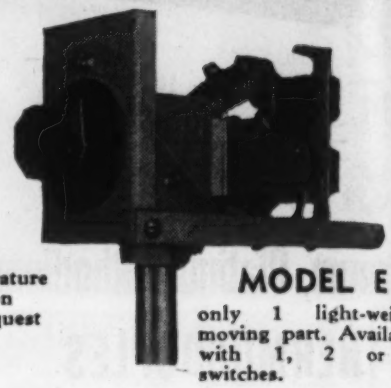
The *E. W. Bliss Co.* will vacate its factory at Brooklyn and will expand at Toledo, Cleveland and Salem, Ohio, meanwhile obtaining a new plant at Englewood, N. J.

Societies

E. A. Buxton has been elected chairman of the committee on steel pipe research, *American Iron & Steel Institute,* succeeding E. P. Corey, who has retired after 52 years in the steel pipe industry. Mr. Buxton is sales manager, pipe and tubes, for the Bethlehem

BURLING
TEMPERATURE
LIMIT SWITCHES

USE NO LIQUIDS . . . NO GASES



Literature on Request

MODEL E
only 1 light-weight moving part. Available with 1, 2 or 3 switches.

As a 3 switch model, Burling Model E is recommended for use (a) where load is divided into 3 parts, (b) where 1 switch is used for controlling, one as a high limit, one as a low limit, (c) to give definite stops or position to a 3 or 4 position diaphragm motor, (d) to give 3 speed control of variable speed motor.

- Accurate, Rugged, Dependable
- Corrosion and heat resisting tube
- Dial Pointer for easy setting
- Locking screw locks temperature setting
- Terminal plate has large screw terminals
- Snap-action Micro-Switch eliminates contact troubles
- Increased Adjustable range to 700-1000°
- Dimensions—7¼" x 2¾" x 3½"

MODEL V-I

For lower temperature range from 0-300°F. Available for minimum of —100° to maximum of 600°F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾" diameter × 4¼" high)

MODEL D

Adjustable range 200-500°F. Temperature range 0-1400°F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½ x 2¾ x 2¾").

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Making Precision Controls for Over 11 Years

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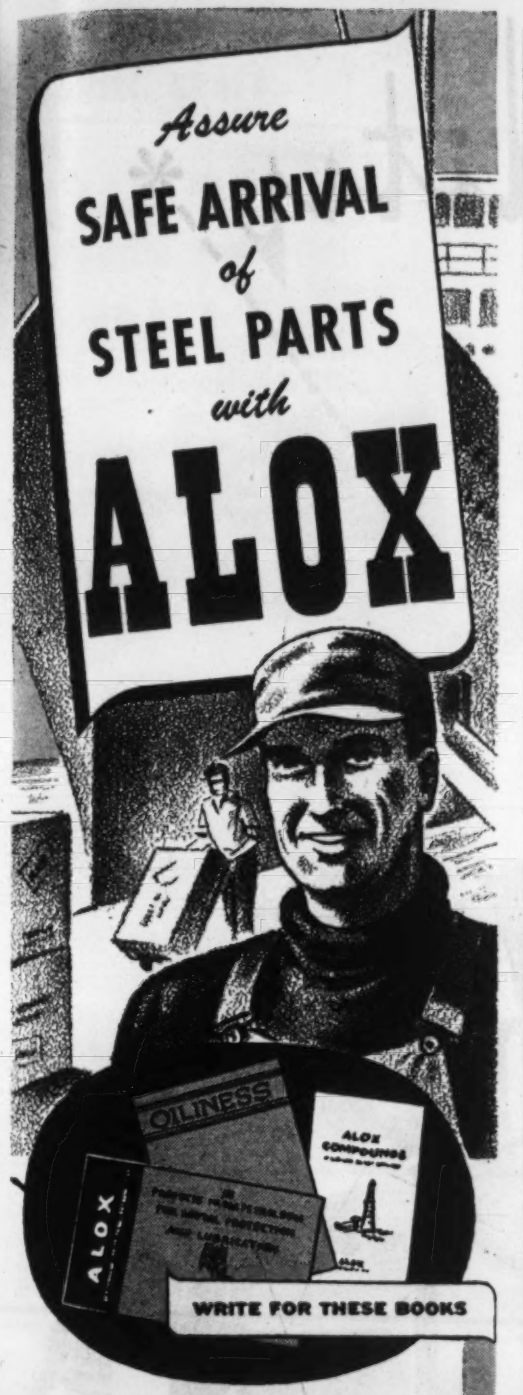

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● Insist on the use of ALOX 388-940-707 inhibitors for the maximum protection of steel parts during fabrication, assembly, storage and shipment.

Successfully used to protect overseas shipment of war equipment during World War II. Today these film forming rust preventives containing ALOX inhibitors are used in the control of corrosion of farm and construction equipment.

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News of...

ENGINEERS COMPANIES SOCIETIES

Steel Co. Oscar I. Strickland, manager, tubular sales, Wheeling Steel Corp., was elected vice chairman of the committee. Factual data prepared by the committee are of value to users of pipe, architects, engineers and salesmen.

The *American Society for Metals* will tender its highest award for technical achievement to F. P. Zimmerli, Detroit metallurgical engineer. Known as the Albert Sauveur Award, it is given "for his basic research in the field of shot peening to increase favorable stresses in the surfaces of metal parts." He pioneered with shot peening in 1929 when his company so treated springs.

Meetings and Expositions

ELECTROCHEMICAL SOCIETY, fall meeting. Boston, Mass. Oct. 15-18, 1947.

NATIONAL LUBRICATING GREASE INSTITUTE, annual convention. Chicago, Ill. Oct. 16-18, 1947.

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS, annual meeting. Chicago, Ill. Oct. 16-17, 1947.

NATIONAL METAL EXPOSITION. Chicago, Ill. Oct. 18-24, 1947.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Fuels Division meeting. Cincinnati, Ohio. Oct. 20-22, 1947.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Iron & Steel and Institute of Metals Divisions. Chicago, Ill. Oct. 20-22, 1947.

AMERICAN INDUSTRIAL RADIUM & X-RAY SOCIETY, annual meeting. Chicago, Ill. Oct. 20-24, 1947.

AMERICAN SOCIETY FOR METALS, annual meeting. Chicago, Ill. Oct. 20-24, 1947.

AMERICAN WELDING SOCIETY, annual meeting. Chicago, Ill. Oct. 20-24, 1947.

NATIONAL METAL CONGRESS. Chicago, Ill. Oct. 20-24, 1947.

AMERICAN CHEMICAL SOCIETY, Pacific Chemical Exposition. San Francisco, Calif. Oct. 21-25, 1947.

AMERICAN MINING CONGRESS convention. El Paso, Texas. Oct. 27-29, 1947.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION. Atlantic City, N. J. Oct. 27-31, 1947.

AMERICAN SOCIETY OF TOOL ENGINEERS, semi-annual meeting. Boston, Mass. Oct. 30-Nov. 1, 1947.

The Oakite Way to Improved Pickling

To streamline your pickling room procedures, use Oakite Pickle Control No. 3 in your hot sulfuric acid solution. An effective aid to better pickling, Oakite Pickle Control No. 3 saves you hours and dollars these 6 ways:

METAL SAVINGS: Records show savings in steel handling costs up to 19¢ per ton.

ACID SAVINGS: Stops wasteful action of acid on metal after oxides are dissolved.

LESS FUMES: Reduces evolution of hydrogen gas. Provides safe atmosphere for personnel.

OVER-PICKLING ELIMINATED: Reduces acid attack on clean areas of metal; thus gives uniform pickling.

REDUCED HYDROGEN EMBRITTLEMENT: Less hydrogen generated means less tendency for occlusion of hydrogen by steel.

CLEANER WORK: Surface active ingredients assure best cleaning and rinsing action.

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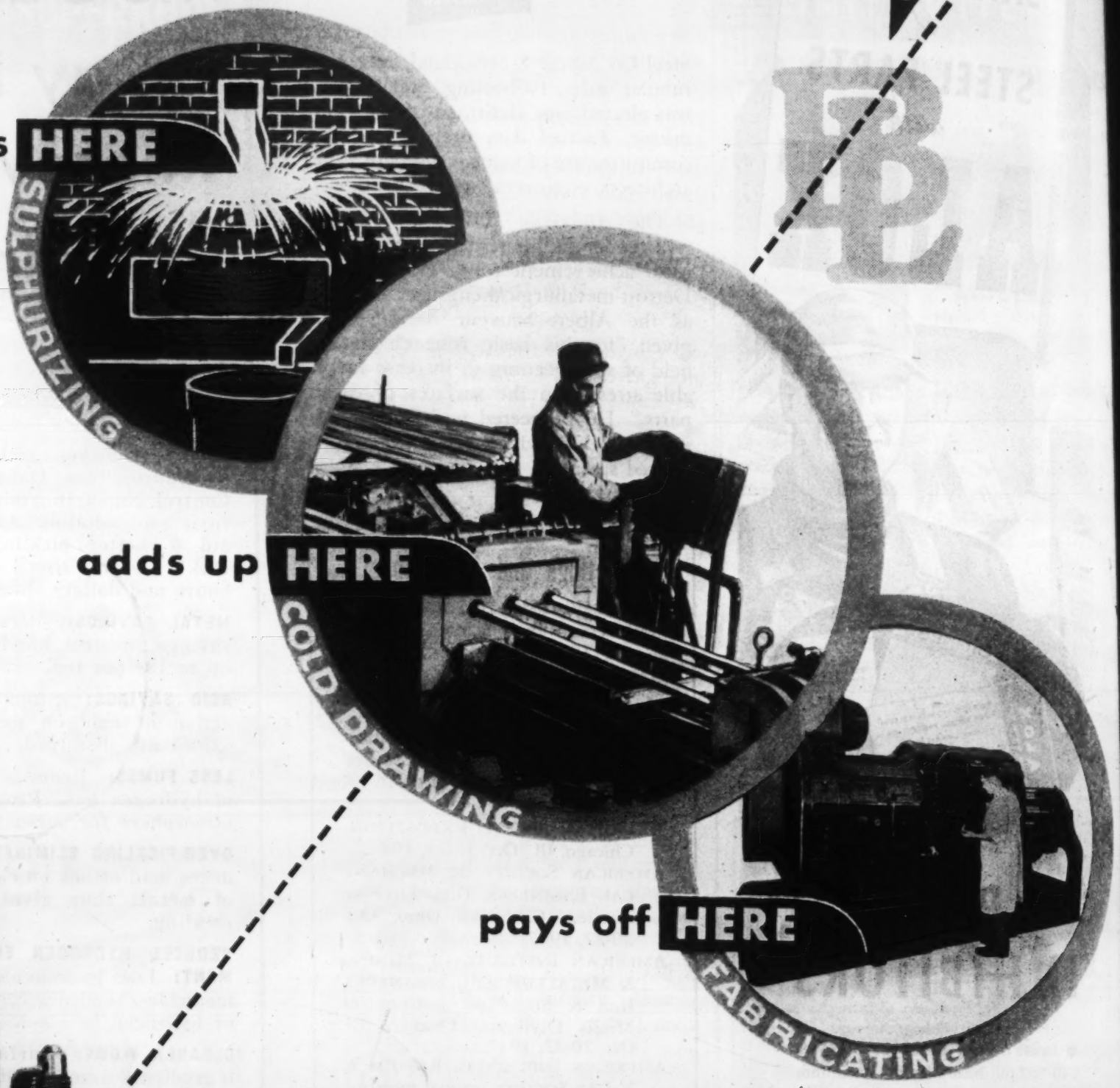
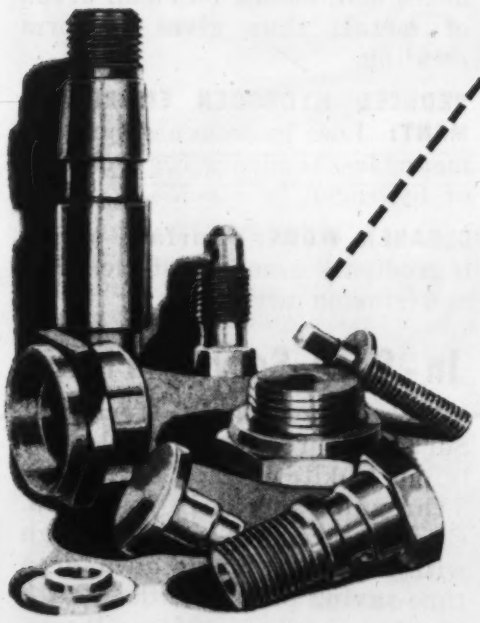
Machinability*





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